Cisco Systems

Cisco Networking Academy Program

CCNA 2:

Routers and Routing Basics v 2.1.4

Student Lab Manual

Lab 2.2.2 Routers - Overview

Estimated time: 20 min.

Objectives:

- Determine the model number of a Cisco router and what physical interfaces (ports) it has.
- Identify the cables attached to the router and what they connect to.
- Check and/or modify HyperTerminal configuration parameters.
- Connect to the router as its console using the PC and HyperTerminal program.
- Determine the IOS version and file name.
- Determine the CPU type, amount of RAM, NVRAM and Flash memory.

Background:

In this lab you will examine a Cisco router to gather information about its physical characteristics and begin to relate Cisco router products to their function. You will determine the model number and features of a specific Cisco router including which interfaces are present and to which cabling and devices they are connected.

A router is basically a dedicated microcomputer that has a Central Processing Unit (CPU), an operating system (Cisco IOS), RAM, and ROM inside. Routers do not have disk drives, keyboards or monitors. One of the ways to configure or program the router is to connect directly to it with a PC or a dumb terminal. The PC provides a monitor and keyboard for the router which is referred to as its "console". The PC becomes the console which allows you to enter commands and communicate directly with the router. In this lab, you will work with a PC workstation using the Windows HyperTerminal (terminal emulation) program to act as a console to the router and you will configure the proper PC serial port settings in order to connect to and communicate with it.

Tools / Preparation:

Prior to starting the lab, the teacher or lab assistant will need to check that a router is available and that a PC workstation is connected as a console with HyperTerminal installed and properly configured to access the router. The router should be exposed with all sides clearly visible so that all physical connections and cables can be inspected. Work in teams of 2 or more. Before beginning this lab you may want to review Chapters 3 and 4 in the Cisco Networking Academy First-Year Companion Guide and Semester 2 On-line Chapter 2.

The following resources will be required:

- Windows PC w/ HyperTerminal installed and configured to access the router
- Cisco Router (16xx or 25xx model)
- Console Cable (Roll-Over) connecting the PC serial port to the router console port
- CAT 5 Ethernet Cable attached to an Ethernet port
- Ethernet hub or switch
- WAN Cable attached to a Serial port

Web Site Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary

Notes:

_____

_____

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_____

_____

Step 1 - Examine the router.

1. What is the model number?

_____

2. Do you see a console port? (Y/N)

_____

What port is it connected to on the console terminal (PC workstation)?

_____

3. What type of cable is the console cable, and is it a roll-over, cross-connect or straight-through cable?

_____

Step 2 - Record all of the interfaces (or port connectors) on the router and, any cable attached.

Explanation: If the port has a cable attached, identify the cable type, connector, and the device attached to the other end. (If a port does not have a cable you should be able to identify the connector type that would be used)

5. Fill in the following table.

Router Interface/ Port	Cable type/	Device and port to which cable is

Identifier	Connector	connected

Step 3 - Review the workstation's 'HyperTerminal' configuration.

Explanation: Click on Start/Programs/Accessories/Communications, and then HyperTerminal. Right Click on the icon that is defined for console access to the Cisco Router and then click Properties. The icon may be named **Cisco.ht** or something similar. If one does not exist you can create it using the settings shown in the answers to the worksheet. On the Properties screen, click the Phone Number Tab and then click the on the Configure button.

6. Fill in the following table with the information indicated.

Configuration Option	Current Setting(s)
COM Port	
Bits per second	
Data bits	
Parity	
Stop Bits	
Flow control	

Step 4 - Display IOS version and other important information related to RAM, NVRAM and Flash memory with the show version command

Task: Connect to the console port on the router and enter the **show version** command.
Explanation: The router will return information about the IOS and memory.

7. What is the IOS version?

_____

8. What is the name of the system image (IOS) file?

_____

9. From where was the router IOS image booted?

_____

10. What type of processor (CPU) and how much RAM does this router have?

11. How many Ethernet interfaces does this router have?

12. How many Serial interfaces?

13. The router backup configuration file is stored in Non-Volatile Random Access Memory (NVRAM). How much NVRAM does this router have?

14. The router operating system (IOS) is stored in Flash memory. How much flash memory does this router have?

Lab 2.2.3.1 Routers - Overview

Estimated time: 20 min.

Objectives:

- Setup the Cisco lab equipment according to the semester 2 topology diagram or analyze the physical connections of an existing lab setup.
- Document the cabling and connections between devices.
- Draw a diagram of your lab equipment setup.

Background:

This lab will help you develop an understanding of how the Cisco lab routers are set up and connected for the Semester 2 topology (see diagram on previous page). You will examine and document the physical connections between these routers and the other lab hardware components such as hubs, switches, and workstations. This lab will utilize the standard setup consisting of 5 routers, 4 hubs, 1 switch, and at least 5 workstations plus all associated cabling and adapters. The next lab 2.2.3.2 will give you an opportunity to document the IP addressing and internal IOS configuration of the routers if they are already configured. If they are not configured, instructions will be provided to configure and test them.

Tools / Preparation:

Prior to starting this lab you will need to have the equipment from the standard 5-router lab available (routers, hubs, switch, etc.). The routers and hubs should be disconnected and stacked. Each cabling type (WAN, LAN, console, power) should be grouped together. If it is not possible to start with equipment disconnected, you should review the steps of the lab with the equipment already connected. This will familiarize you with the physical connections and device interfaces.

The routers may be pre-configured by the instructor or lab assistant with the correct IP interface settings etc. The workstations may also be pre-configured to have the correct IP address settings prior to starting the lab. The routers and workstations should be labeled as indicated in this lab.

Start with the routers, switches, hubs, and cabling disconnected if possible. Your team will need to connect them according to the topology diagram in the overview at the beginning of this lab and then document your findings. This lab requires that you assemble the routers into the standard lab topology or as close as possible depending on the equipment you have. Work in teams of 3 or more. Before beginning this lab you may want to review Chapters 3 and 4 in the Cisco Networking Academy First-Year Companion Guide and Semester 2 On-line Chapter 2.

The following resources will be required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.

- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 3 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Web Site Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary

Notes:

Step 1 - Router Lab LAN/WAN Preliminary Planning.

When setting up the lab equipment from scratch you will need to give some thought to the questions listed below. Even if you are starting with an existing assembled lab setup, you should review all steps and answer all questions to become more familiar with how the routers are connected. Even though you may not be actually connecting the equipment, you should locate, examine and document the cabling and physical connections between routers, hubs and workstations.

- Where should the PC's be placed?
- Where should the routers be placed?
- Where should the switch and hubs be placed?
- How should the Ethernet, serial and power cables be run?
- How many outlets and powerstrips will be needed?
- Which PC connects to which router?
- Which PC connects to which hub or switch?
- Which Router connects to which hub or switch?
- How should devices and cabling be labeled?

Step 2 - Arrange Lab Equipment.

Your arrangement of the routers and equipment will vary depending on space and physical setup of your lab area. The goal is to group each combination of router/hub/workstation closely together since they can represent separate LANs and geographical locations in the real world. It is easier to see the relationships between equipment with this arrangement. Equipment should be positioned so that all interfaces are facing the same direction and so that cabling and connections can be accessed easily.

A. **Table or work surface setup -** If you are setting the routers out over tables or desks, place the labeled routers side by side in order from left to right (Lab-A, Lab-B…). Place the switch on top of router Lab-A. Place hub 1 on top of the switch and hubs 2, 3 and 4 on top of routers B, C and D. Place router Lab-D with its hub on top of Lab-E since they are connected to the same LAN. Workstations should be located close to or on the tables for the routers and hubs to which they connect.

B. **Single rack setup -** If you have a single 19" network equipment rack, mount the first router, Lab-A up high in the rack and mount the switch just above it. Mount the other routers in the rack in sequence from top to bottom with about 4 to 6 inches between each router. Place a hub on top of the switch above router Lab-A and on top of routers B, C and D. Workstations should be spread out around the rack to allow workspace and will be numbered from left to right.

C. **Multiple rack setup -**If you have multiple racks, put a router and hub in each rack from top to bottom and left to right depending on how many racks you have. Place workstations as close to the routers as possible while still allowing workspace.

Step 3 - Connect Serial WAN Cabling.

Next you will connect serial cables (DCE-DTE) between routers. With this lab setup, the router interface serial 0 (S0) is connected to the DCE cable. DCE refers to Data Circuit-Terminating Equipment (or Data Communications Equipment) connections and represents the clocking end of the synchronous WAN link. The DCE cable has a large female V.35 (34-pin) connector on one end and a DB-60 connector on the other end which attaches to the router serial interface. Interface serial 1 (S1) is connected to the DTE (Data Terminal Equipment) cable. The DTE cable has a large male V.35 connector on one end and a DB60 on the other end which attaches to the router serial interface. Cables are also labeled as DCE or DTE.

1. Examine the cables and connections on the routers and document the connections in the table:

From Router Name	Interface	To Router Name	Interface

Step 4 - Connect the Router Ethernet Cabling.

For routers that have an AUI (Attachment Unit Interface) Ethernet 0 (E0) or E1 port, you will need an external transceiver which converts the DB15 AUI to an RJ-45 10BASE-T connector. The 2500 series routers usually have an AUI port. The 1600 series has both AUI and RJ-45 ports and you can use the RJ-45 port without the need for the external transceiver. All Ethernet cabling from routers to hubs or switches must be Category 5 (Cat 5) and wired "straight-thru" (pin 1 to pin 1, pin 2 to pin 2 etc.). Connect the Ethernet cabling as indicated in the diagram and then label the cabling at each end. Hubs should be numbered Hub 1, Hub 2, etc.

2. Record the router Ethernet interfaces in use and which hub (or switch) they attach to in the table:

From Router Name	Router Interface	To which Ethernet Device
Lab-A		
Lab-B		
Lab-C		
Lab-D		
Lab-E		
Lab-F		

Step 5 - Connect the Workstation Ethernet Cabling.

Place the PC's at their planned locations and label them (WS-1, WS-2…) from left to right according to the diagram. Run straight-through CAT 5 cables from each PC to where the switch and hubs are located. Connect the Ethernet cabling as indicated and then label the cables at each end depending on what device and interface they connect to. The following table shows the connections for all 10 workstations. Connect at least one workstation to each hub or switch.

3. Indicated which Ethernet device each workstation connects to in the table below:

From Workstation	To which Ethernet Device
WS-1	
WS-2	
WS-3	
WS-4	
WS-5	
WS-6	
WS-7	
WS-8	
WS-9	
WS-10	

Step 6 - Connect the Console Workstations to Routers.

Connect one end of the rollover cables from workstations 4, 6, 8, 9, and 10 to the console interface of routers Lab-A, B, C, D and E. Connect the other end of each of the rollover cables to an RJ-45-to-DB-9 serial connector. Connect the serial connector to the serial ports of the 5 workstations. Label the cables at each end.

4. What type of cable is the console cable?

Step 7 - Connect Power Cords to All Devices.

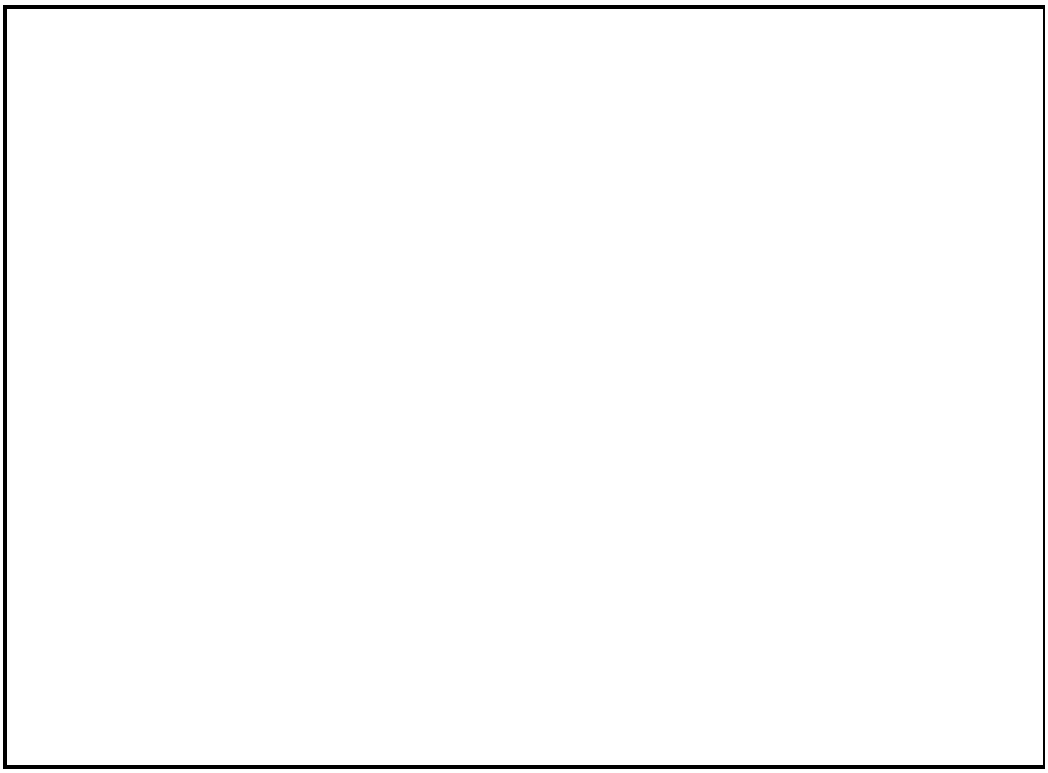
Plug in and turn on all devices. Verify all of the devices are activated by checking their indicator lights.

5. Are the link lights for the switch, the hubs and the Network Interface Cards (NICs) in the workstations on?

Are the OK lights on the back of the routers on?

Step 8 - Draw your lab diagram.

In the space provided below or in your engineering journal redraw the router lab diagram to match your physical setup. Label all LAN (Ethernet) and WAN (serial) interfaces and cabling.



Lab 2.2.3.2 Routers - Overview

Estimated time: 20 min.

Objectives:

- Analyze the routers in an existing lab setup and document the IOS configuration.
- Use the **show running-config** command at each router to determine attached IP Network numbers, Interfaces, IP addresses and subnet mask information for the Local Area Networks (LANs) and Wide Area Networks (WANs) in use.
- Use the Control Panel / Network icon or winipcfg.exe utility at each workstation to determine IP address, subnet mask and default gateway settings.
- Use the Ping command to test the router and workstation connections.
- Use IOS commands to configure routers to the standard lab setup (optional).

Background:

This lab will help you develop an understanding of how the Cisco lab routers and workstations are configured for the Semester 2 topology (see diagram on previous page). You will use IOS commands to examine and document the IP network configurations of each router. You will also check the IP configuration of each workstation to ensure that there is full connectivity between all nodes in the lab setup. If the routers are not already configured you may (optionally) use the instructions at the end of the worksheet to configure each router. This will require additional time and probably some assistance from your instructor or a lab assistant since you will not have covered this material in the text, labs or online chapters yet.

Tools / Preparation:

Prior to starting this lab you will need to have the equipment for the standard 5-router lab available (routers, hubs, switches, cables, etc.). The routers should be pre-configured by the instructor or lab assistant with the correct IP interface settings etc. if possible. The workstations should also be pre-configured to have the correct IP address settings prior to starting the lab. The routers, hubs and workstations should be labeled.

This lab assumes that you have completed the prior lab and that the lab equipment (routers, hub, workstations etc.) are assembled and connected in the standard lab topology. Work in teams of 3 or more. Before beginning this lab you may want to review Chapters 12 and 13 in the Cisco Networking Academy First-Year Companion Guide and Semester 2 On-line Chapter 2.

The following resources will be required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).

- 3 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight-through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Web Site Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary

Notes:

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Step 1 - Verify That All Physical Connections are Correct.

Review the standard semester 2 lab diagram in the overview section of this lab or the diagram you created in the prior lab and check all physical devices, cables and connections. Verify that the routers have been configured correctly (physically and internally) by the instructor or lab assistant.

Step 2 - Examine and Document Router Configurations. (If the routers have not been configured, skip to step 5).

A. Log on to the first router Lab-A. Verify that you have a good console connection from the workstation to the router and start the HyperTerminal program (Start/Programs/Accessories/Communications). Enter the password cisco if prompted to enter user mode. The prompt should be Lab-A>

B. Enter the Privileged Exec mode. Type enable at the router prompt. Enter the password of class if prompted. The prompt should now be Lab-A# C. Gather information about the router. Physically examine each router and make note of the interfaces (E0, S0 etc.) you see. Enter the **show running-config** command to gather information. The router will respond with the active configuration file currently in RAM.

1. Fill in the table below with IP interface information for each of the five routers.

Router Name	Lab-A	Lab-B	Lab-C	Lab-D	Lab-E
Model Number					
Interface EO IP Address					
Interface EO Subnet Mask					
Interface E1 IP Address					
Interface E1 Subnet Mask					
Interface S0 Subnet Mask					
Interface S0 Clock Rate					
Interface S1 IP Address					
Interface S1 Subnet Mask					
Other Interfaces					

2. With the information gathered from the **show running-config** command at router Lab-A, answer the following questions:

a. What is the routing protocol used?

b. What are the networks that are directly connected to the interfaces?

c. What is the clock rate of interface S0 on router Lab-A?

d. What is the password for Telnet lines VTY 0 thru 4?

Step 3 - Examine and document the workstation configurations. (If the workstations have not been configured, skip to step 6).

A. Verify the workstation IP configuration.

Click on Start/Settings and select Control Panel. Double-click on the Network icon. Select the TCP/IP protocol and click the Properties button. For each workstation, click the IP Address tab and record the current settings for the IP address and Subnet mask in the table below. Click the Gateway tab and record the IP address of the default gateway in the table: (should be the IP address of the E0 router interface that the hub is connected to for each workstation). You may also use the **winipcfg.exe** utility or **ipconfig.exe** (Windows NT or 2000) at the DOS command prompt to verify settings at each workstation.

3. Fill in the IP configuration with information obtained from each workstation.

Wkstn #	Wkstn. IP addr	Wkstn. Subnet mask	Def. Gateway IP addr.

Step 4 - Test the router lab connectivity.

A. Ping from router to router. Begin with router Lab-A and use the console workstation connection to it. Start the HyperTerminal program and ping the S1 interface of router Lab-B. This will verify that the WAN link between Lab-A and Lab-B is OK. Ping the serial interfaces of the other routers. **Lab-A> ping 201.100.11.2**

4. Was the ping from router Lab-A to Lab-B successful?

B. Ping from workstation to router. Begin with a workstation connected to the first hub. Click Start/Programs/MS-DOS Prompt and ping the S1 interface of router Lab-B. This will verify that the workstation's IP configuration and the WAN link between Lab-A and Lab-B is OK. Ping the serial interfaces of the other routers. **C:\WINDOWS> ping 201.100.11.2**

5. Was the ping from router Lab-A to Lab-B successful?

Step 5 - Configure the routers for the standard lab setup (optional).

If the routers need to be configured, refer to the answers section 6 for the steps necessary. You will need to obtain assistance from your instructor or lab assistant.

Step 6 - Configure the workstations for the standard lab setup (optional).

If the workstations need to be configured, refer to the answers section 7 for the steps necessary. You will need to obtain assistance from your instructor or lab assistant.

Step 7 - The OSI model and associated TCP/IP protocol stack layer.

Task: Fill out the following charts based on your knowledge of the OSI model.
Explanation: Your understanding of the OSI model will greatly increase your ability to absorb and categorize networking information as you learn it.

1. List the 7 layers of the OSI model from the top to the bottom. Give a mnemonic word for each layer that can help you remember it and then list the keywords and phrases that describe the characteristics and function of each.

Layer #	Name	Mnemonic	Key Words and Description of Function
7			
6			
5			
4			
3			

2			
1			

2. List the 7 layers of the OSI model. Indicate the TCI/IP Protocol Stack layer that is associated with each OSI layer. List the encapsulation unit used to describe the data grouping at each layer.

Layer #	Name	Encapsulation Unit or Logical Grouping
7		
6		
5		
4		
3		
2		
1		

Lab 3.2.1 Router user interface - Overview

Estimated time: 60 min.

Objectives:

- Login to a router in both user and privileged modes.
- Use several basic router commands to determine how the router is configured.
- Become familiar with the router HELP facility.
- Use the command history and editing features.
- Logout of router.

Background:

This lab will introduce the Cisco Internetwork Operating System (IOS) command line user interface. You will login to the router and use different levels of access to enter commands in "User Mode" and "Privileged Mode". You will become familiar with the commands available in each mode (User or Privileged) and use the router HELP facility, history and editing features. The IOS command interface is the most common method of configuring a Cisco router. You will see many commands available, especially in privileged mode. Do not be overwhelmed. As with many things, the 80/20 rule applies. You can do 80% of what you need to do on a daily basis with 20% of the commands available.

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the Hyperterminal program that is configured to connect to the router. You may want to review Chapter 12 in the Cisco Networking Academy First-Year Companion Guide and review Semester 1 on-line chapter 3 prior to starting this lab. You will need to be familiar with these commands:

- ?
- enable
- logout
- show ?
- show running-config
- exit

Resources Required:

- PC with monitor, keyboard, mouse, and power cords, etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC.
- HyperTerminal PE program configured for router console access.
- PC connected to the router console port with a roll-over cable.

Websites Site Resources:

- Routing basics
- General information on routers

- 2500 series routers
- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

Step 1 - Login to the router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

1. What prompt did the router display? What does the prompt symbol mean?

Step 2 - Enter the help command.

Task: Enter the help command by typing (?) at the router prompt.
Explanation: The router will respond with all of the available commands for User Mode.

2. List eight (8) available commands from the router response. Try to pick ones that might be more commonly used.

Step 3 - Enter enable mode.

Task: a. From user EXEC mode, enter the privileged mode by using the (**enable**) command.
b. Enter the enable password of (class).

Explanation: Entering the (**enable**) command and using the password (**class**) allows you privileged mode access to the router.

3. Was " **enable**" one of the commands available from step 2?

4. What changed in the router prompt display and what does it mean?

Step 4 - Enter the help command.

Task: Enter the help command by typing (?) at the router prompt.
Explanation: The router will respond with all of the available commands for Privileged-Mode.

5. List ten (10) available commands from the router response. Try to pick ones that might be more commonly used.

Step 5 - List all show commands.

Task: Enter show followed by a space then a (?).
Explanation: The router will respond with the available subcommands for show.

6. Is " **running-config**" one of the available commands from this user level?

Step 6 - Look at the running router configuration.

Task: Enter **show running-config** at the router prompt.
Explanation: Using the **show running-config** command displays the active configuration file for the router that is stored in **RAM**.

6a. List 6 key pieces of information you can get from this command:

Step 7 - Continue looking at the configuration.

Task: When the word "more" appears, hit the space bar.
Explanation: By pressing the space bar the router will display the next page of information.

7. What happened when you hit the space bar?

Step 8 - Using the command history.

Task: Press the up arrow or (**Ctrl-P**)
Explanation: Ctrl-P or the "up" arrow commands lets you review your command history.

8. What happened at the router prompt?

Step 9 - Exit the router.

Task: Enter **exit** at the router prompt.

Lab 3.2.2 Router user interface modes - Overview

Estimated time: 20 min.

Objectives:

- To identify the six basic and two optional router modes
- To become familiar with the router prompt for each mode
- Use several commands that will enter specific modes

Background:

When using router operating systems such as Cisco IOS, you will have to know each of the different user modes a router has and what each one of them is for. Memorizing every command in all of the user modes would be time consuming and pointless. Try to develop an understanding of what commands and functions are available with each of the modes. There are six main modes available with most routers:

1. User EXEC Mode
2. Privileged EXEC Mode (also known as Enable Mode)
3. Global Configuration Mode
4. Router Configuration Mode
5. Interface Configuration Mode
6. Sub-interface Configuration Mode

In this lab you will work with the six most common modes listed above. Two other modes that are used less frequently are **RXBoot mode** and **Setup mode**. RXBoot is a maintenance mode that can be used for password recovery. Setup mode presents an interactive prompted dialog at the console that helps a new user create a first-time basic configuration. Both RXBoot and Setup modes will be covered in later labs.

You can determine which mode you are in by looking at the prompt. Each of the modes will have a different prompt. Depending on which mode you are in, certain commands may or may not be available. You can always type a question mark ? to see what commands you can use. The most common mistake made when working at the command line is to enter a command and get an error because you are in the wrong configuration mode. You need to be familiar with each mode and how to get in and out of each mode.

Tools / Preparation:

Prior to starting the lab you will need to connect a PC (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. Work individually or in teams. Before beginning this lab you may want to read the Networking Academy First Year Companion Guide, Chapter 12 and 15. You should also review On-line Chapter 3.

Resources Required:

- PC with monitor, keyboard, mouse, and power cords, etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC

- HyperTerminal PE program configured for router console access
- PC connected to the Router console port with a roll-over cable

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
IP routing protocol IOS command summary

Notes:

For this lab, you and your group should try and discover what each of the modes are and what each of them do. Be sure to take note of what the prompts on the router look like in each of the modes. For example, when in interface configuration mode, the prompt is: Router(config-if)# (where router is the name of the router you are working with)

1. Match the different router modes with their appropriate prompts (For example: 1-A, 2-B, etc). Fill in the table by writing out the correct prompt selecting from the list of choices provided below:

Mode Description	Mode Prompts
1. User EXEC Mode	
2. Privileged EXEC Mode	
3. Global configuration mode	
4. Router configuration mode	
5. Interface configuration mode	

A. Router#
B. Router>
C. Router(config-if) #
D. Router(config-router) #
E. Router(config) #

Match the different router modes with their functionality. Fill in the table by writing letter of the correct choice provided below:

Mode Description	Mode Prompts
1. User EXEC Mode	
2. Privileged EXEC Mode	
3. Global configuration mode	
4. Router configuration mode	
5. Interface configuration mode	

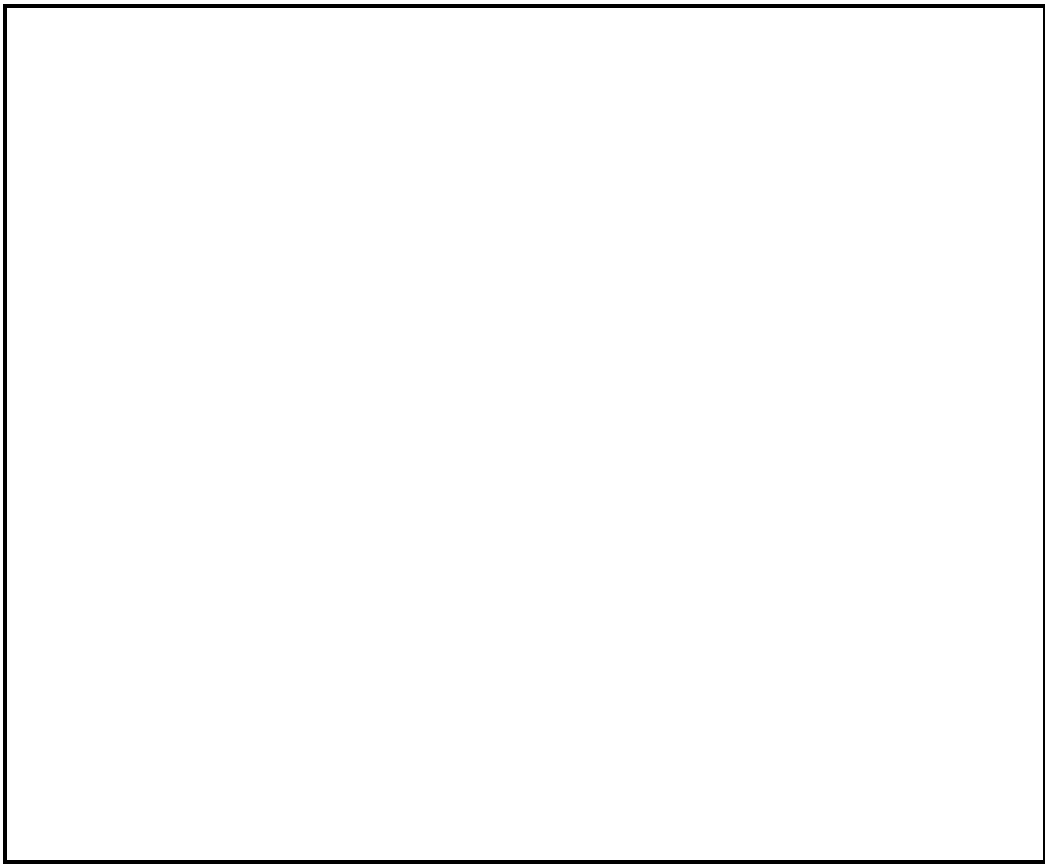
A. Detailed examination of router, debugging and testing. Remote access.
B. Setting of IP addresses and subnet masks.
C. Simple configuration commands.
D. Limited examination of router. Remote access.
E. Routing protocols.

From the prompt shown below, write a command that will allow you to enter the mode listed:

Desired Mode	Current Prompt	Command	Explanation
Privileged EXEC Mode	Router >		
Global Config Mode	Router #		
Interface Config Mode	Router (config.)#		
Router Config Mode	Router (config.)#		

Router Modes Diagram Exercise

In the space provided or in your Engineering Journal, draw a hierarchical diagram of the various router modes listed in the background section of the lab. At the top of the hierarchy you should have the initial router mode that comes up when you boot up the device. The bottom should have more specific modes. If two or more modes have equal priority choose any order.



Reflection:

In your journal, describe what general function the following modes serve:

1. Config Interface:

_____

2. Enable mode:

_____

Also answer the following:

1. What did you learn from this lab?

_____

2. Where/when did you have difficulties?

_____

3. How did you overcome them?

4. How can you apply what you learned in this lab toward future labs?

Lab 4.2.4 Router show commands

Estimated time: 30 min.

Objectives:

- Become familiar with the basic router **show** commands
- Retrieve the current running configuration of the router in RAM using **show running-config**
- View the backup configuration file in NVRAM using **show startup-config**
- View the IOS file information using **show flash** and **show version**
- View current status of the router interfaces using **show interface**
- View status of any configured layer 3 protocol using **show protocol**

Background:

This lab will help you become familiar with the router **show** commands. The show commands are the most important information gathering commands available for the router. The **show running-config** (or "show run") is probably the single most valuable command to help determine the current status of a router because it displays the active configuration file running in RAM. The **show startup-config** (or "show start") command displays the backup configuration file that is stored in non-volatile or NVRAM. This is the file that will be used to configure the router when it is first started or rebooted with the "reload" command. All of the detailed router interface settings are contained in this file.

The "**show flash**" command is used to view the amount available and amount used of flash memory. Flash is where the Cisco Internetwork Operating System (IOS) file or image is stored. The **show arp** command displays the router's IP to MAC to Interface address mapping. The **show interface** command displays statistics for all interfaces configured on the router. **Show protocol** command displays global and interface-specific status of configured layer 3 protocols (IP, IPX, etc.).

Tools / Preparation:

Prior to starting the lab you will need to connect a PC with HyperTerminal to a router using the router's console interface with a roll-over cable. Work individually or in teams. Before beginning this lab you may want to read the Networking Academy First Year Companion Guide, Chapter 13. You should also review On-line Chapter 4. Be familiar with the following **show** commands:

- **Show ?**
- **Show clock**
- **Show hosts**
- **Show users**
- **Show history**
- **Show arp**
- **Show flash**
- **Show running-config**
- **Show startup-config**

- **`Show interface`**
- **`Show protocol`**
- **`Show version`**

Resources Required:

- PC with monitor, keyboard, mouse, and power cords etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal PE program configured for router console access
- PC connected to the Router console port with a roll-over cable

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

_____

_____

_____

_____

_____

Step 1 - Log on to router.

Explanation: Connect to the router and login. Enter the password **`cisco`** if prompted.

Step 2 - Enter the `help` command.

Task: Enter the help command by typing (**?**) at the router prompt.
Explanation: The router responds with all commands available in User-Mode.

1a. What did the router reply back with ?

_____

1b. Are all router commands available at the current prompt?

_____

2. Is **show** one of the options available?

_____

Step 3 - Display help for the show command.

Task: Enter the **show ?** command
Explanation: The router responds with sub-commands available as part of the show command in user mode.

3. List three user mode sub-commands available as part of the **show** command.

Show - sub command	**Description**

Step 4 - Display IOS version and other important information with the show version command.

Task: Enter the **show version** command.
Explanation: The router will return information about the IOS that is running in RAM.

4. With information from the show version command - Answer the questions below:

a. What is the IOS version?

_____

b. What is the name of the system image (IOS) file?

_____

c. Where was the router IOS image booted from?

_____

d. What type of processor (CPU) and how much RAM does this router have?

_____

e. How many Ethernet interfaces does this router have? ____ How many Serial interfaces? ____

f. The router backup configuration file is stored in Non-Volatile Random Access Memory (NVRAM). How much NVRAM does this router have?

_____

g. The router operating system (IOS) is stored in Flash memory. How much flash memory does this router have?

_____

h. What is the Configuration register set to?

_____

Step 5 - Displaying the routers time and date.

Task: Enter the **show clock** command.
Explanation: The **show clock** command will show the current time and date.

5. What information is displayed with **`show clock`**?

Step 6 - Displaying a cached list of host names and addresses.

Task: Enter **`show hosts`** command.
Explanation: The **`show hosts`** command displays a cached list of hosts and all of their interface IP addresses.

6. What information is displayed with **`show hosts`**?

Step 7 - Display users that are connected to the router.

Task: Enter **`show users`** command.
Explanation: The **`show users`** command displayed users that are connected to the router.

7. What information is displayed with **`show users`**?

Step 8 - Showing the command buffer.

Task: Enter **`show history`** command.
Explanation: The **`show history`** command displays a history of commands that have been entered.

8. What information is displayed with **`show history`**?

Step 9 - Enter the privileged mode.

Task: a. From user EXEC mode, enter privileged EXEC mode using the **`enable`** command.
b. Enter the enable password of **`class`**.

Explanation: Enter the enable mode from the User EXEC mode.

9a. What command did you use to enter privileged mode?

9b. How do you know if you are in privileged-mode?

Step 10 - Enter the help command.

Task: Enter **show ?** command at the router prompt.
Explanation: The router responds with the sub-commands available within the **show** command for Privileged-mode.

10 a. What did the router reply back with when **show ?** was entered at the #?

_____

10 b. How is this output different from the one you got in user mode in step 3?

_____

Step 11 - Show the router ARP table.

Task: Enter the **show arp** command at the router prompt.

Step 12 - Show information about the Flash memory device.

Task: Enter **show flash** at the router prompt.
Explanation: The router will respond with information about the flash memory and what IOS file(s) are stored there.

12. Document the following information with **show flash**.

a. How much flash memory is available and used?

_____

b. What is the file that is stored in flash memory?

_____

c. What is the total size in bytes of the flash memory?

_____

Step 13 - Show information about the active configuration file.

Task: Enter **show running-config** (or show run) at the router prompt.
Explanation: The router will display information on how it is currently configured.

13. What important information is displayed with **show run**?

_____

Step 14 - Show information about the backup configuration file.

Task: Enter **show startup-config** (or show start) at the router prompt.
Explanation: The router will display information on the backup configuration file stored in NVRAM.

14. What important information is displayed with **show start** and where in the router is this information kept?

Step 15 - Display statistics for all interfaces configured on the router

Task: Enter **`show interface`** at the router prompt.
Explanation: The router shows information about the configured interfaces.

15a. Find the following information for interface Ethernet 0 with **`show interface`**:

1. What is MTU?
2. What is Rely?
3. What is Load?
4. What is a Runt?
5. What is a Giant?

15b. Find the following information for interface serial 0 with **`show interface`**:

1. What is the IP address and subnet mask?
2. What data link layer encapsulation is being used?
3. What does "Serial0 is up, line protocol is up" mean?

Step 16 - Display the protocols configured on the router.

Task: Enter **`show protocol`** at the router prompt.
Explanation: This command shows the global and interface-specific status of any configured Layer 3 protocols.

16.What important information is displayed?

16b. Enter **`exit`** at the router prompt.

Lab 4.3.5 CDP neighbors

Estimated time: 30 min.

Objectives:

- Use CDP commands to get information about neighboring networks and routers.
- Display information on how CDP is configured for its advertisement and discovery frame transmission.
- Display CDP updates received on the local router.

Background:

In this lab you will use the **show cdp** command. Cisco Discovery Protocol (CDP) discovers and shows information about directly connected Cisco devices (routers and switches). CDP is a Cisco proprietary protocol that runs at the data link layer (layer 2) of the OSI model. This allows devices that may be running different network layer 3 protocols such as IP or IPX to learn about each other. CDP begins automatically upon a device's system startup, however if you are using Cisco IOS Release 10.3 or newer version of IOS you must enable it on each of the device's interfaces by using the **cdp enable** command. Using the command **show cdp interface** you will gather information CDP uses for its advertisement and discovery frame transmission. Use **show cdp neighbors** and **show cdp neighbors detail** to display the CDP updates received on the local router.

Tools / Preparation:

Prior to starting the lab you will need to connect a PC with HyperTerminal to a router using the router console interface with a roll-over cable. Work individually or in teams. Before beginning this lab you may want to read the Networking Academy First Year Companion Guide, Chapter 13. You should also review On-line Chapter 4. Be familiar with the following **show** commands:

- **show interfaces**
- **show cdp**
- **show cdp interface**
- **show cdp neighbors**
- **show cdp neighbors detail**

Resources Required:

- PC with Windows operating system and HyperTerminal installed
- Router connected to the PC with a console roll-over cable
- At least 3 routers interconnected via Ethernet or WAN simulation cables

Websites Sites Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers

Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

Step 1 - Log on to router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Gather information about the router you logged into by issuing the show interfaces command.

Task: Enter **show interfaces** command at the router prompt.
Explanation: The router shows information about the configured interfaces.

1. Document the following information about the router:

a. What is the name of the router?

b. List IP address and subnet mask of the interfaces.

Interface	IP Address	Subnet mask

c. List operational status of each interface.

Interface	Interface Up or Down? (Carrier Detect Signal)	Line Protocol Up/Down? (Keep Alives Being received)

Step 3 - Display the values of the CDP timers, the interface status, and encapsulation used.

Task: Enter **`show cdp interface`** command at the router prompt.
Explanation: The router responds with CDP information on all interfaces that have CDP enabled.

Global CDP settings can be seen using the **`show cdp`** command by itself.

2. How often is the router sending CDP packets?

_____

3. What is the holdtime value?

_____

Step 4 - Display the CDP updates received on the local router.

Task: Enter **`show cdp neighbors`** command at the router prompt.
Explanation: The router will respond with information about its neighbors that have CDP enabled.

4. Fill in the following table:

Device and Port ID	Local Interface	Hold Time	Capability	Platform

Step 5 - Display details about CDP updates received on the local router.

Task: Enter **`show cdp neighbors detail`** from the router prompt.
Explanation: The router will display the entry address(es), IOS version, and the same information as the **`show cdp neighbors`** command.

5. Fill in the following table:

Neighbor device name			
Neighbor device type			
IP address of interface attached to your router			
Port ID of your router that the neighbor is on			
Port ID of neighbor router that your router is on			
IOS version of neighbor			

router			

Step 6 - Telnet to your neighbor router and issue `show cdp neighbor`.

Task:

a. Telnet to neighboring router by entering **`telnet`** (***hostname of router or IP address***).
b. Enter the password **`cisco`**.
c. Enter **`show cdp neighbor`** at the router prompt you have telneted to.

Explanation: The router will respond with information about its neighbors that have CDP enabled.

NOTE:

Perform this step at router lab-b, lab-c, or lab-d and telnet to your two neighbors on either side.

6. Fill in the following tables:

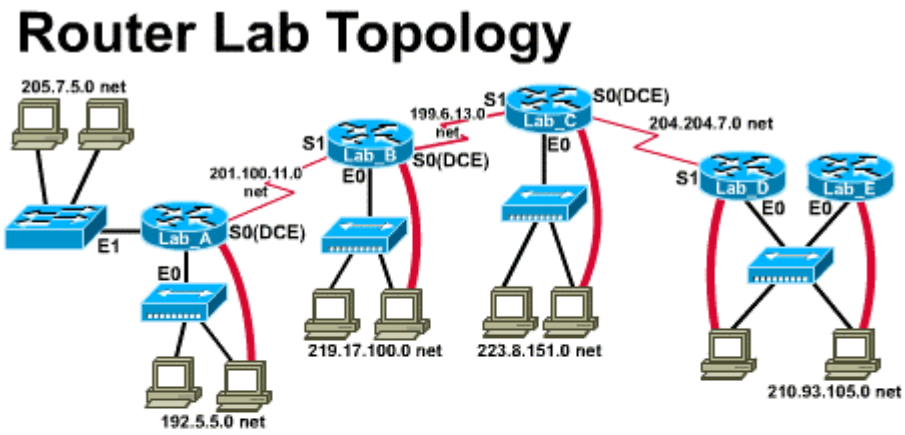
First neighbor

Device and Port ID	Local Interface	Hold Time	Capability	Platform

Second neighbor

Device and Port ID	Local Interface	Hold Time	Capability	Platform

Lab 4.4.2 Remote telnet access



Router Name - Lab_A	Router Name - Lab_C	Router Name - Lab_E
Router Type - 2514	Router Type - 2501	Router Type - 2501
E0 = 192.5.5.1	E0 = 223.8.151.1	E0 = 210.93.105.2
E1 = 205.7.5.1	S0 = 204.204.7.1	SM = 255.255.255.0
S0 = 201.100.11.1	S1 = 199.6.13.2	
SM = 255.255.255.0	SM = 255.255.255.0	
Router Name - Lab_B	Router Name - Lab_D	
Router Type - 2501	Router Type - 2501	
E0 = 219.17.100.1	E0 = 210.93.105.1	
S0 = 199.6.13.1	S1 = 204.204.7.2	
S1 = 201.100.11.2	SM = 255.255.255.0	
SM = 255.255.255.0		

Estimated time: 30 min.

Objectives:

- Use the **`telnet`** command to remotely access other routers.
- Verify that the application layer between source and destination is working properly.
- Retrieve information about remote routers using router show commands.
- Retrieve CDP information from routers not directly connected to you.

Background:

In this lab you will work with the Telnet (remote terminal) utility to access routers remotely. You will telnet from your "local" router into another "remote" router in order to simulate being at the console on the remote router. This procedure will use your router's Telnet client software and the remote router's Telnet server software. You can also telnet from your workstation as a client into any router connected to your network. In addition, you can telnet into Cisco Ethernet Switches. You cannot, however, telnet from a router or a workstation into another Windows client or server since the Windows operating system does not support the Telnet server daemon. A daemon (pronounced demon) is a UNIX term that refers to a program running on a server that accepts requests for services. You can decide whether to allow others to telnet into your router or you may require a password for incoming Telnet sessions. Telnet connections are referred to as line

VTY 0 4 in the router configuration file. The router can support up to 5 simultaneous incoming Telnet sessions (0 thru 4).

Telnet is a good troubleshooting tool since it can be used to access remote routers to gather information when there are problems or when configuration changes are necessary. It also tests from the OSI Application layer of the source host down through its Physical layer and then across the network and back up the protocol stack of the destination router. This allows you to verify the Application layer software between source and destination hosts. You will use telnet to access a remote router and use **`show cdp neighbors`** to gather information from routers that are not directly connected to you.

Tools / Preparation:

Prior to starting the lab you will need to connect a PC with HyperTerminal to a router using the router console interface with a roll-over cable. Work individually or in teams. Before beginning this lab you may want to read the Networking Academy First Year Companion Guide, Chapter 13. You should also review On-line Chapter 4. Be familiar with the following commands:

- **`telnet ?`**
- **`telnet router-name or IP`**
- **`show CDP neighbors`**
- **`show interfaces`**
- **`show protocols`**
- **`enable`**
- **`show running-config`**
- **`show startup-config`**

Resources Required:

- PC with Windows operating system and HyperTerminal installed
- Router connected to the PC with a console roll-over cable
- At least 3 routers interconnected via Ethernet or WAN simulation cables

Websites Sites Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

Step 1 - Log on to the router.

Task: Connect to the router and login. Enter the password **cisco** if prompted.

1. What prompt did the router display?

Step 2 - Enter the help facility.

Task: Enter **telnet ?** at the router prompt
Explanation: The router will respond with help with the **telnet** command.

2. What did the router reply with?

Step 3 - Telnet from router to router.

Task: Enter **telnet router-name** or IP address at the router prompt to connect to a remote router.
Explanation: The router will prompt you for User Access Verification of the router you remotely access. Enter the password **cisco**

3. What prompt did the router display?

Step 4 - Show interfaces.

Task: Enter **show interfaces** at the router prompt.
Explanation: The router will respond with information about its interfaces.

4. List the interfaces, their IP address and subnet mask.

Interface	IP Address	Subnet mask

Step 5 - Show protocol.

Task: Enter **show protocols** at the router prompt.
Explanation: This command shows the global and interface-specific status of any configured layer 3 protocols.

5. Fill in the table below with the information that was generated by the router you are remotely accessing.

Interface	Is there a Carrier Detect signal	Are the keepalive messages being received?

Step 6 - Enter privileged mode while connected to the remote router with telnet.

Task:

a. Enter **enable** at the command prompt.
b. Enter the password of **class**

Explanation: You use the **enable** command to enter privileged EXEC mode

6. What prompt did the router display? What mode are you in?

Step 7 - Show information about the active configuration file of the remote router.

Task: Enter **show running-config** at the remote router prompt.
Explanation: The remote router will display information on how it is currently configured.

7. What file are you viewing on the remote router? Where is this file stored?

Step 8 - Show information about the backup configuration file of the remote router.

Task: Enter **show startup-config** at the router prompt.
Explanation: The remote router will display information on the backup configuration file stored in NVRAM.

8. What file are you viewing on the remote router? Where is this file stored?

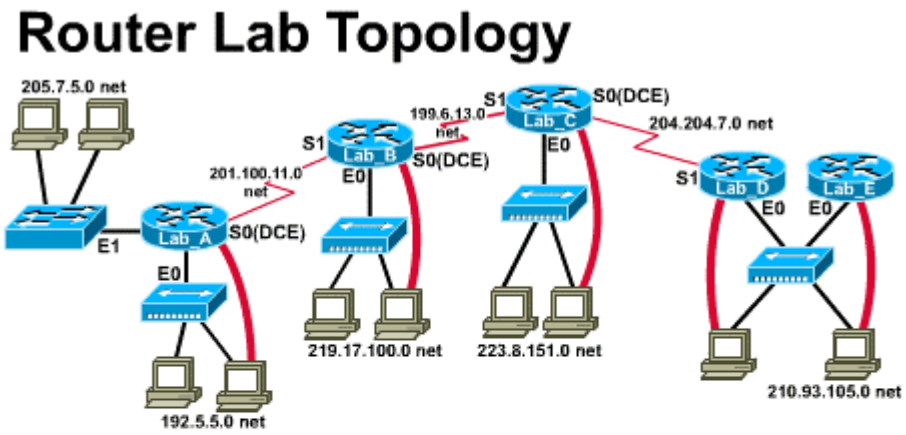
9. What information do you see concerning the line VTY connections?

Step 9 - Display the CDP updates received on the local router.

Task: Enter **`show cdp neighbors`** command at the router prompt.
Explanation: The router will respond with information about its neighbors that have CDP enabled.

10. List all device IDs that are connected to the remote router with which you have a Telnet session.

Lab 4.4.3 ICMP ping



Router Name - Lab_A Router Type - 2514 E0 = 192.5.5.1 E1 = 205.7.5.1 S0 = 201.100.11.1 SM = 255.255.255.0	Router Name - Lab_C Router Type - 2501 E0 = 223.8.151.1 S0 = 204.204.7.1 S1 = 199.6.13.2 SM = 255.255.255.0	Router Name - Lab_E Router Type - 2501 E0 = 210.93.105.2 SM = 255.255.255.0
Router Name - Lab_B Router Type - 2501 E0 = 219.17.100.1 S0 = 199.6.13.1 S1 = 201.100.11.2 SM = 255.255.255.0	Router Name - Lab_D Router Type - 2501 E0 = 210.93.105.1 S1 = 204.204.7.2 SM = 255.255.255.0	

Estimated time: 30 min.

Objectives:

- Use the **ping** command to send ICMP Datagrams to target host.
- Verify that the network layer between source and destination is working properly.
- Retrieve information to evaluate the path-to-host reliability.
- Determine delays over the path and whether the host can be reached or is functioning.

Background:

In this lab you will use ICMP or **I**nternet **C**ontrol **M**essage **P**rotocol. ICMP will give you the ability to diagnose basic network connectivity. Using **ping xxx.xxx.xxx.xxx** (xxx. represents the numbers in an IP address) will send an ICMP packet to the specified host and then wait for a reply packet from that host. You can **ping** the host name of a router but you must have a static host lookup table in the router or DNS server for name resolution to IP addresses.

Ping is an excellent tool for troubleshooting layers 1 though 3 of the OSI model. If you cannot connect to a host computer (such as a server) but you can ping the server's IP address, then your problem is probably not with the physical cabling connections, the NICs or the routers between you and the server. With this lab,

you will also have a chance to see the differences between using the **ping** command from a router and from a workstation.

Tools / Preparation:

Prior to starting the lab you will need to connect a PC with HyperTerminal to a router using the router console interface with a roll-over cable. You should have access to the standard 5-router lab if possible. Work individually or in teams. Before beginning this lab you may want to read the Networking Academy First Year Companion Guide, Chapter 13 and you should also review On-line Chapter 4.

Resources Required:

- PC with Windows operating system and HyperTerminal installed
- Router connected to the PC with a console roll-over cable
- At least 3 routers interconnected via Ethernet or WAN simulation cables

Websites Sites Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

Step 1 - Log on to router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

1a. What prompt did the router display?

1b. What does it mean?

Step 2 - Display a cached list of host names and addresses.

Task: Enter **`show host`** at the router prompt.
Explanation: The router will display information about host to Layer 3 (IP) address mappings, how this information was acquired and the age of the entry.

2. List four (4) host names and the first IP address listed for each one.

Host name	IP Address

Step 3 - Test layer 3 addressing - Ping from router to router.

Task: Enter **`ping xxx.xxx.xxx.xxx`** where xxx.xxx.xxx.xxx is an IP address from one of the other hosts listed above. Repeat with all IP addresses you listed.
Explanation: The router sends an Internet Control Message Protocol (ICMP) packet to verify the hardware connection and network layer address. Since your PC is acting as the console to the router, you are pinging from your router to another router.

3. Were you able to **`ping`** all the IP address?

4. List four (4) important pieces of information that you receive back from issuing the **`ping`** command.

Step 4 - Examine the output generated by the `ping` command.

5. Look at the example of the **`ping`** command generated by a router.

```
lab-b#ping 210.93.105.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echoes to 210.93.105.1, timeout is 2
seconds: !!!.!
Success rate is 80 percent (4/5), round-trip min/avg/max =
68/68/168 ms
```

a. What does the exclamation point (!) indicate?

_____

b. What does the period (.) indicate?

_____

c. What does the **ping** command test for?

_____

Step 5 - Access the workstation command prompt.

Task: From a Windows 95/98 or NT workstation click on Start/Programs/MS DOS Command prompt. This will open a Command Prompt window.
Explanation: Using the command prompt to ping the routers allows you to test that the TCP/IP stack and default gateway on the workstation are configured and working properly.

Step 6 - Test the workstation default gateway.

Task: Using the command prompt enter **ping** and the IP address of the workstation default gateway. Default gateway is the nearside router interface IP address.
Explanation: By pinging your default gateway you are able to test if you can successfully send packets to and from the router that is directly connected to your LAN.

6. Are you able to **ping** your default gateway?

_____

(Hint: You may need to check the TCP/IP settings using the Windows Control panel, network icon)

Step 7 - Test layer 3 addressing from a workstation to remote router.

Task: Using the command prompt enter **ping** and the IP address of a remote router.
Explanation: This will test layer 3 connectivity between your workstation and the remote router.

7. Is the output from the workstation's **ping** command the same as the output from the **ping** command from a router?

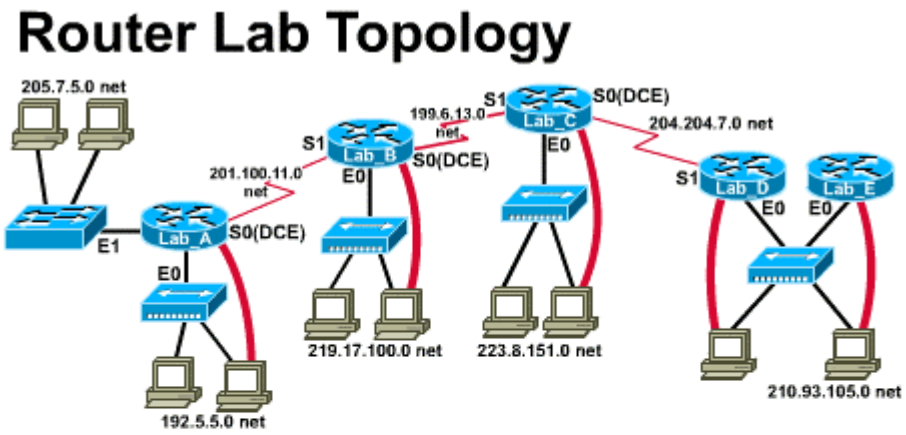
_____

Step 8 - Test the connections to other remote routers.

Task: Using the command prompt enter **ping** and the IP address of another remote router.
Explanation: This will test layer 3 connectivity between your workstation and the other remote routers.

8. List the differences between the router's **ping** command and the workstation **ping** command

Lab 4.4.4 Traceroute command



Router Name - Lab_A Router Type - 2514 E0 = 192.5.5.1 E1 = 205.7.5.1 S0 = 201.100.11.1 SM = 255.255.255.0	Router Name - Lab_C Router Type - 2501 E0 = 223.8.151.1 S0 = 204.204.7.1 S1 = 199.6.13.2 SM = 255.255.255.0	Router Name - Lab_E Router Type - 2501 E0 = 210.93.105.2 SM = 255.255.255.0
Router Name - Lab_B Router Type - 2501 E0 = 219.17.100.1 S0 = 199.6.13.1 S1 = 201.100.11.2 SM = 255.255.255.0	Router Name - Lab_D Router Type - 2501 E0 = 210.93.105.1 S1 = 204.204.7.2 SM = 255.255.255.0	

Estimated time: 30 min.

Objectives:

- Use the **`traceroute`** Cisco IOS command from source router to destination router.
- Use the **`tracert`** Windows OS command from source workstation to destination router.
- Use the **`show ip route`** command to display the router's routing table.
- Verify that the network-layer between source, destination and each router along the way is working properly.
- Retrieve information to evaluate the end-to-end path reliability.
- Determine delays at each point over the path and whether the host can be reached.

Background:

In this lab you will use the IOS **`traceroute`** command. The **`traceroute`** command uses ICMP packets and the error message generated by routers when the packet exceeds its Time To Live (TTL). When you initiate the **`trace`** command to a target host the router sends an ICMP echo-request packet with the TTL set to one (1). The first router in the path to the target host receives the ICMP echo-request packet and sets the TTL to zero (0). The first router then sends an ICMP Time-exceeded message back to the source. The source router then sends an ICMP echo-request packet with the TTL set to two (2). The first router receives the ICMP echo-request and sets the TTL to one (1) and (delete

enter) sends it to the next router in the path to the target host. The second router receives the ICMP echo-request and sets the TTL to zero (0) then sends an ICMP Ttime-exceeded message back to the source. The source then sends an ICMP echo-request with a TTL set to 3. This cycle continues until an ICMP echo-reply is received from the target host or until a ICMP destination-unreachable message is received. This allows you to determine the last router to be reached in the path to the target host. This is a troubleshooting technique called fault isolation.

Tools / Preparation:

Prior to starting the lab you will need to connect a PC workstation with HyperTerminal to a router using the routers console Interface with a roll-over cable. This lab should be done at the router console station. You may want to review Chapter 13 in the Cisco Networking Academy First-Year Companion Guide and review Semester 2 Online Chapter 4 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`traceroute ip xxx.xxx.xxx.xxx`** - (Where xxx.xxx.xxx.xxx is the IP address of the host you want to trace). The **`ip`** after the command is the default and may be omitted.
- **`traceroute hostname`** (Where host name is a name that can be resolved to an IP address). **`traceroute`** is a Cisco IOS command.
- **`tracert xxx.xxx.xxx.xxx`** - (Where xxx.xxx.xxx.xxx is the IP address of the host you want to trace). **`tracert`** is a Windows 95/98 or NT command.
- **`tracert hostname`** - (Where host name is a name that can be resolved to an IP address).
- **`show ip route`** - This will show you the IP routing table - the directions that the router uses to determine how it will direct traffic across the network.

Resources Required:

- PC with monitor, keyboard, mouse, and power cords etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal program
- Access to multiple routers

Websites Sites Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

Step 1 - Log on to router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

1a. What prompt did the router display?

1b. What does it mean?

Step 2 - Enter `trace` (abbreviated form of traceroute).

Task: Enter **trace** at the router prompt.

2. What did the router respond with?

> **NOTE:**
>
> After entering the **trace** command, you need to hit twice to return to the command line.

Step 3 - Enter `trace ?`

Task: Enter **trace ?** at the router prompt.

3. What did the router respond with?

Step 4 - Get help with `trace ip` command.

Task: Enter **trace ip ?** at the router prompt.

4. What did the router respond with?

Step 5 - Trace route from end router to end router.

Task: Enter **`trace ip xxx.xxx.xxx.xxx`** (where **`xxx.xxx.xxx.xxx`** is the IP address of the target destination; remember that **`ip`** is the default) Note: You will want to do this lab using one of the end routers and **`trace IP`** to the other end router. (note: ip is the default)
Explanation: **`Trace`** command is the ideal tool for finding where data is being sent in your network.

5. List the host name and IP address of the routers that the ICMP packet was routed through.

Host Name	IP Address

Step 6 - Trace the route to all other routers on your network.

Task: Repeat Step 5 with all other routers on your network.

Step 7 - Use `tracert` from a MS-DOS command prompt.

Task: From the console workstation click on Start/Programs/MS DOS Command Prompt. An MS-DOS Command Prompt window will open up. Enter **`tracert`** and the same IP address that you used in step 5.
Explanation: By using the MS-DOS window you will be using the TCP/IP stack of the workstation to begin the trace to the destination. The first hop will be your default gateway or the near side router interface on the LAN that the workstation is connected to.

6a. List the host name and IP address of the router that the ICMP packet was routed through.

Host Name	IP Address

6b. Why is there one more entry in the output of the tracert command when you trace from the computer command prompt to the target host?

Step 8 - Trace a route over the Internet.

Task: From a Windows 95/98 or NT workstation that has Internet access click on Start/Programs/MS DOS Command Prompt. An MS-DOS Command Prompt window will open up. Enter **`tracert www.cisco.com`**.

7a. What is the IP address of www.cisco.com?

_____

7b. How many hops did it take to get to www.cisco.com? If a packet passes through a router it is considered one (1) hop and the TTL of the packet is decremented by one (1).

_____

Step 9 - View the routing table of the router.

Task: From the router prompt enter **`show ip route`**.
Explanation: This will show you the router's routing table.

8. List the IP network number addresses that are directly connect to you.

_____

_____

Lab 4.4.7 Show interfaces & clear counters

Estimated time: 30 min.

Objectives:

- Use the **`show interfaces`** command to display statistics for the router's interfaces.
- Use the **`clear counters`** command to clear statistics for the router's interfaces.

Background:

In this lab you will use **`show interfaces`** and **`clear counters`**. The router keeps very detailed statistics about data traffic it has sent and received on its interfaces. This is very important in troubleshooting a network problem. The **`clear counters`** command resets the counters that are displayed when you issue the **`show interface`** command. By clearing the counters you get a clearer picture of the current status of the network.

Tools / Preparation:

Prior to starting the lab you will need to connect a PC workstation with HyperTerminal to a router using the routers console Interface with a roll-over cable. This lab should be done at the router console station. You may want to review Chapter 13 in the Cisco Networking Academy First-Year Companion Guide and review Semester 2 Online curriculum Chapter 4 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`show interfaces`**
- **`clear counters`**

Resources Required:

- PC with monitor, keyboard, mouse, and power cords etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal program
- Access to multiple routers

Websites Sites Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

Step 1 - Log on to router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Enter the show interfaces command (abbreviated: sh int).

Task: Enter **show interfaces** at the command prompt.
Explanation: The **show interfaces** command displays packet statistics which reflect router operation since the last time the counters were cleared.

1. Fill in the following information for all interfaces in use:

Interface	Ethernet 0	Ethernet 1	Serial 0	Serial 1
Hardware address				
Packet input				
Packet output				
Last clearing of counters				

Step 3 - Enter the help command.

Task: Enter the help command by typing (**?**) at the router prompt.
Explanation: The router will respond with all available commands for User-Mode.

2. What is the significance of entering (**?**) at the command prompt?

Step 4 - Enter Privileged EXEC mode.

Task: Enter **enable** at the router prompt. The router will ask you for the enable password, enter **class**.
Explanation: Entering the **enable** command and entering the password **class** allows you privileged mode access to the router.

3. What prompt is the router showing?

Step 5 - Get help with the clear command.

Task: Enter **`clear ?`** at the router prompt.
Explanation: The **`clear ?`** command will display sub commands for clear.

4. Is **`counters`** one of the sub commands that is listed?

_____

5. What is the description of **`counters`**?

_____

Step 6 - Clear all interface counters.

Task: Enter **`clear counters`** at the router prompt. The router will ask you to confirm with (**`Y`**)
Explanation: The **`clear`** command will clear all interface statistics on the router.

Step 7 - Confirm that the counters have been cleared.

Task: Enter **`show interfaces`** at the routers command prompt.
Explanation: The show interface command displays the statistics, which reflect router operation since the last time the counters were cleared.

6. Have the counters been set to zero (0)?

_____

Step 8 - Generate network traffic.

Task: Ping all routers interfaces in the lab network. Do this several times.
Explanation: By pinging the interfaces of all routers on the labs network you will generate network traffic. You can use the **`Up arrow`** or **`CTL-P`** to retrieve previous commands and change the IP address to the next destination.

Step 9 - Show interface statistics on the router.

Task: Enter **`show interface`** at the router prompt
Explanation: The **`show interfaces`** command displays the statistics, which reflect router operation since the last time the counters were cleared.

7. Fill in the following information in the table for all interfaces:

Interface	Ethernet 0	Ethernet 1	Serial 0	Serial 1
Hardware address				
Packet input				
Packet output				
Last clearing of counters				

Step 10 - Show interface statistics terminology.

Task: Enter **`show interfaces`** at the router prompt.
Explanation: The router shows information about the configured interfaces. Review the terms used for various interfaces and statistics. These can be helpful in troubleshooting.

8. Find the following information for interface Ethernet 0 with **`show interfaces`**:

a. What is MTU?

b. What is Rely?

c. What is Load?

d. What is a Runt?

e. What is a Giant?

9. Find the following information for interface serial 0 with **`show interfaces`**:

a. What is the IP address and subnet mask?

b. What data link layer encapsulation is being used?

c. What does "Serial0 is up, line protocol is up" mean?

Lab 4.5.1 Troubleshooting tools challenge

Estimated time: 45 min.

Objectives:

- Identify what troubleshooting tools (IOS commands) are needed to gather basic information about your network.
- Apply what you have learned in past labs to draw a logical diagram of the network.

Background:

As you know, having the topology of a network is extremely useful. It allows a network administrator to know exactly what equipment he or she has in what area (for bandwidth needs), how many devices are on the network and the physical layout of the network. In this lab you will need to figure out what a topology looks like based on the information you can gather while navigating through the network using IOS commands.

Through the use of show commands, you should be able to see which interfaces are up (using **`show interface`**), what devices the router is connected to (using **`show CDP neighbors`**) and how the user can get there (using **`show protocols`**). With the information received from the show commands, you should be able to remotely access the neighboring routers (using **`telnet`**) and through the use of troubleshooting commands (such as **`ping`**and **`trace`**) you should be able to see which devices are connected. Your final goal is to construct a logical topology drawing of the network by making use of all the above commands without referring to any diagrams ahead of time.

Tools / Preparation:

Prior to starting this lab you will need to have the equipment for the standard 5-router lab available (routers, hubs, switches, cables, etc.). The routers should be pre-configured by the instructor or lab assistant with the correct IP interface settings etc. The workstations should also be pre-configured to have the correct IP address settings prior to starting the lab. The routers, hubs and workstations should be labeled. You may also work with a portion of the standard lab setup (3 or more of the routers) connected differently than the standard topology if time permits and try to determine the topology.

This lab assumes that you have completed the prior labs and that the lab equipment (routers, hub, workstations, etc.) are assembled and connected in the standard lab topology. Work in teams of 3 or more. Before beginning this lab you may want to review Chapters 12 and 13 in the Cisco Networking Academy First-Year Companion Guide and Semester 2 On-line Chapters 3 and 4.

Resources Required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).

- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 3 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Websites Sites Resources:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Step 1 - Gather information about the network.

Use the standard 5-router lab setup or a subset of 3 or more routers. Verify and document the topology of the network that you are working with or have constructed. You will only be able to connect to the console of one of the routers to find out all of the information about the other routers and other devices connected to you.

A. Connect the console to one of the routers in your network. (All information about the physical structure of the network must be obtained from only one console connection.)

1. What command do you use to enter privileged EXEC mode?

_____

B. Gather information about the router your console is connected to.

2. What command do you use to gather information about the router you are on?

_____

C. Gather information about the devices that are connected to your router.

3. What command do you use to gather information about neighboring devices?

_____

D. Gather information about devices on your network but not directly connected to you.

4. You have gathered information about all interfaces on the router you are working with. You also have the IP address of the devices that are directly

connected to the router you are working with. With the information obtained describe how and what commands you will need to use to gather more detailed information about devices not directly connected to your router.

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_____

Step 2 - Draw a logical topology of the network.

Using the troubleshooting tools that you have learned from the prior labs in this module, construct a network diagram based on a given topology. In your journal, draw out the logical topology of this network. Include all routers, hubs and switches. Be sure to indicate exactly where there are interfaces. For example, if there is a serial connection from router 1 to router 2, indicate that on the routers. If there is an Ethernet connection to a hub indicate that. Label the diagram with the proper IP addresses and Subnet masks and indicate which end is DCE and which is DTE for each WAN link.

5. Draw the network diagram with the information you have obtained in Step 1.

Lab 5.2.3 Router setup command - Overview

Estimated time: 30 min.

Objectives:

- Become familiar with the router setup mode.
- Understand what global parameters can be configured in setup mode.
- Understand what interface parameters can be configured in setup mode.

Background:

In this lab you will use the command **setup** to enter setup mode. Setup is a Cisco IOS utility (program) that can help get some of the basic router configuration parameters established. Setup is not intended as the mode for entering complex protocol features in the router. Rather the purpose of setup mode is to bring up a minimal configuration for any router that cannot find its configuration from some other source.

There are two ways to enter setup mode. If the router cannot find its configuration file then it will enter setup mode or setup dialog automatically. The other way to enter setup mode is to enter the **setup** command at the command line while in privileged mode. The setup dialog prompts you for basic setup options such as which protocols you will be using, the IP address and subnet mask for each interface the router has. The setup dialog provides default values for most of the configurable options. You can either accept these or enter your own. If setup does not provide a prompted entry for specific interface information you will have to manually enter those commands at a later time. With this lab you will run the setup utility but will not save the configuration.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard 5-router lab available. The NVRAM of the router you will be configuring should be erased. At the start of this section the instructor or lab assistant should logon to each router in the enable exec mode and issue the erase startup-config command, then issue the reload command. This will force the routers to come up with a blank configuration. The IP configuration for the associated workstation should also be changed so that it is incorrect. The answer section includes examples of the detailed command sets that the students will have to master. The instructor will review your configuration when finished.

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal program that is configured to connect to the router. You may want to review Chapter 14 in the Cisco Networking Academy First-Year Companion Guide and review semester 2 online curriculum lesson 5 prior to starting this lab. Work individually or in teams. Be familiar with the following command:

- `setup`

Resources Required:

- PC connected to the router console port with a roll-over cable
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal PE program configured for router console access
- PC connected to the Router console port with a roll-over cable

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

_____

_____

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Step 1 - Login to the router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Enter privileged mode.

Task:
a. Enter **enable** at the command prompt.
b. Enter the password of **class**.
Explanation: You use the **enable** command to enter privileged EXEC mode.

Step 3 - Enter the help command.

Task: Enter the help command by typing (**?**) at the router prompt.
Explanation: The router will respond with all available commands for Privileged-Mode.

1. Was **setup** one of the commands available?

_____

Step 4 - Enter setup mode.

Task: Enter **`setup`** at the router prompt.
Explanation: Entering the **`setup`** command will start setup mode and execute a question-driven initial configuration routine referred to as the system configuration dialog.

Step 5 - Continue with setup dialog.

Task: Enter yes or press the **Return/Enter** key to continue the setup dialog.
Explanation: The router will ask you if you want to continue with configuration dialog.

2. What is the importance of the word in the square brackets?

_____

Step 6 - Show the current interface summary.

Task: Press the **Return/Enter** key or type yes.
Explanation: The router will ask "First, would you like to see the current interface summary?" you can press the **Return/Enter** key to accept the default answers.

3. Fill in the following table with the information provided.

Interface	IP-Address	OK	Method	Status	Protocol

Step 7 - Configure global parameters.

Task: Configure the router using the default settings to any questions the router asks.
Explanation: Make sure that you enter **`class`** as the enable secret password. Make sure you use something different (such as cisco) for the enable password.

Step 8 - Configure interface parameters.

Task: Configure the router using the default settings to any questions the router asks.
Explanation: Setup mode will now configure any interfaces present on the router.

Step 9 - Configuration command script.

Task: Answer **NO** to the question "Use this configuration?"
Explanation: The router will display the configuration command script then will prompt you if you want to save this configuration.

4. If you were to answer yes to the question "Use this configuration?", where would this information be saved?

Step 10 - Enter setup mode.

Task: Enter setup mode.
Explanation: Repeat this lab but this time as you enter setup mode change the default answers except for the **`enable password`** (use **`class`**). Remember to say NO to the question "Use this configuration?"

Lab 5.3.1 Router setup challenge - Overview

Estimated time: 60 min.

Objectives:

- Apply what you have learned in chapter 14 in the Cisco Networking Academy First-Year Companion Guide, online chapter 5 and Lab 5.2.3 on the setup utility.
- Demonstrate your ability to subnet a class B IP address.
- Learn to use setup mode to set basic configuration parameters for the router.
- Use HyperTerminal to capture the running configuration for the routers.

Background:

When you first open up a router and the operating system is loaded, you have to go through the process of initial setup. In this scenario, you have just received a shipment of new routers and you need to setup a basic configuration. You have received a class B IP network address of 156.1.0.0, and you will need to subnet your class B address using 5 bits for your subnets. Use the standard 5-router diagram on the previous page to determine which subnetwork numbers and which IP addresses you will use for the 8 networks you will need to define. For this lab, setup all five routers. Be sure to configure the router you are using with the console port.

Tools / Preparation:

Prior to starting this lab you will need to have the equipment for the standard 5-router lab available (routers, hubs, switches, cables, etc.). If the routers are configured then the Lab Assistant or Instructor will have to erase the configuration before you begin. The routers, hubs and workstations should be labeled.

This lab assumes that you have completed the prior lab and that the lab equipment (routers, hub, workstations, etc.) are assembled and connected in the standard lab topology. Work in teams of 3 to 5. Before beginning this lab you may want to review Chapters 14 in the Cisco Networking Academy First-Year Companion Guide and Semester 2 On-line Chapter 5.

Resources Required:

- One Floppy Disk.
- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 3 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary

Notes:

Step 1 - Login to the router in enable mode and issue the setup command.

If the router has not been configured it may enter setup automatically. If the router is configured you will need to login to the router, enter enable mode, and issue the **`setup`** command.

Step 2 - Follow the on-screen prompts and use the following information:

Use Lab-A to Lab-E as the host name for the routers. The enable secret password should be **class**. Use **IGRP** for your routing protocol with autonomous system number **1**. Be sure to specify the correct IP addresses and number of subnet bits for each interface. When you are asked to "Use this configuration?" answer **`yes`**

1. How many subnets can you create with a 5-bit mask and a Class B network address?
2. How many hosts per subnet ?
3. What will the subnet mask be in decimal?

Step 3 - Document you configuration.

After answering yes to "Use this configuration?" you will want to capture the output from the **`show running-config`** command of all five routers to hand into your instructor. You do this in HyperTerminal by clicking on the Transfer then

Capture Text. In the Capture Text window you can specify the file name and where you want the capture text to be saved. Save your text to a floppy disk and name the text file output from each router the same as the router name (lab-a.txt, lab-b.txt etc.) Then click on start button to start capturing text.

Now, from an enable mode prompt issue the **`show running-config`** command. After capturing the running-configuration click on Transfer then Capture text, then Stop. The output from the show running-configuration will be on the floppy disk. Take your floppy disk to a computer that has a printer and print the captured text, or display the text file for your instructor.

Step 4 - Repeat for all 5 routers.

4. Ask your instructor to check the answers section of the lab regarding the running config for all 5 routers using the class B address with five bits of subnetting.

Lab 6.1.2 Router config HyperTerminal - Overview

Estimated time: 30 min.

Objectives:

- Capture the running configuration of a router to an ASCII text file with HyperTerminal
- Edit or modify the captured text file with a text editor such as Notepad
- Upload the text file to configure another router using HyperTerminal

Background:

In this lab you will use the Windows terminal emulation program, HyperTerminal, to capture and upload a router configuration as an ASCII text file. This saved copy can be used as a backup for the current router or it can be used as a basis for a new router configuration. When adding another router to a network it is a good idea to base the new configuration on an existing one, rather than "reinvent the wheel."

Using Notepad to edit the text is the preferred tool. WordPad and other feature rich word processing programs require you to perform a 'save as' function, using the 'text document' option. This is NOT necessary when using Notepad since it does NOT attach formatting headers, whereas most other WP programs do. The addition of these headers will corrupt your configuration file. Since each router may have different interfaces, you must analyze the captured router configuration and modify it to suit the new configuration. Additionally, the IP addresses assigned to the interfaces on the new router must be different than those on the original router.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard 5-router lab available. The NVRAM of the router you will be configuring should be erased. At the start of this section the instructor or lab assistant should log onto each router in the **`enable exec`** mode and issue the **`erase startup-config`** command, then issue the **`reload`** command. This will force the routers to come up with a blank configuration. The IP configuration for the associated workstation should also be changed so that it is incorrect. The answer section includes examples of the detailed command sets that the students will have to master. The instructor will review your configuration when finished.

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal program that is configured to connect to the router. You may want to review Chapter 13 in the Cisco Networking Academy First-Year Companion Guide and review semester 2 online curriculum Chapter 6 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`show running-config`**
- **`erase startup-config`**
- **`reload`**
- **`configure terminal`**

- **`copy running-config startup-config`**

Resources Required:

- PC with monitor, keyboard, mouse, and power cords, etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal PE program configured for router console access
- PC connected to the Router console port with a roll-over cable

Notes:

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Step 1 - Login to the router

Explanation: Connect to the router and login. Enter the password **`cisco`** if prompted.

Step 2 - Enter the Privileged EXEC mode.

Task:

a. From user EXEC mode, enter privileged EXEC mode using the **`enable`** command.
b. Enter the enable password of **`class`**.

Explanation: Enter the enable mode from the User EXEC mode.

Step 3 - Enter the show running-config (abbreviated: sh run).

Task: Enter **`show running-config`** at the command prompt.
Explanation: Using **`show running-config`** command displays the active configuration file for the router that is stored in RAM.

1. List all of the interfaces on the router: (Answers will vary)

_____

_____

Step 4 - Start capturing the configuration file.

Task: Start the process of copying the router configuration to a text file.
Explanation: HyperTerminal will capture all text displayed on its screen to a text file.

In HyperTerminal click on the "Transfer" menu option, then click on "Capture Text." When prompted, provide a path and name to capture the configuration to. Use the name of the router for the filename and use .txt for the extension.

2. Write down the name and location of this file:

_____

Step 5 - Enter the `show running-config` (abbreviated: `sh run`).

Task: Enter **`show running-config`** at the command prompt.
Explanation: Using **`show running-config`** command displays the active configuration file for the router that is stored in RAM. Enter the **`sh run`** command. Press the space bar when the "-More -" prompt appears.

Step 6 - Stop capturing the configuration file.

Task: Discontinue capturing the router configuration to a text file.
Explanation: HyperTerminal will stop capturing any text displayed on its screen.

In HyperTerminal click on the "Transfer" menu option, then click on "Capture Text." A new menu appears. Click on "Stop."

Step 7 - Clean up captured configuration file.

Task: Remove any unnecessary information from the captured configuration.
Explanation: The captured text file will have information not required for configuring a router, for example the "- More -" prompts. Note that the exclamation mark "!" is the comment command in a router configuration.

Click on the Windows Start button, then click on "Run" and type "Notepad" and press the enter key. In Notepad click on File/Open. Find the file you made note of in Step 4, and click "Open." Delete the lines that say:

- **Sh run**
- **Building configuration...**
- **Current configuration:**

Delete each line that has the "- More -" prompt. Note that there will be characters that appear as black boxes on these lines. Delete any lines that appear after the word "End". Save the clean version of the configuration by clicking on File/Save. Close Notepad (File/Close) and switch back to HyperTerminal.

Step 8 - Erase the `startup configuration`.

Task: Enter command **`erase startup-config`** (abbreviated: **`erase start`**) at the router prompt.
Explanation: The **`erase startup-config`** command deletes the configuration file from **NVRAM**. Caution should be used with this command since the router may execute it without prompting for confirmation.

Step 9 - Confirm that startup configuration has been deleted.

Task: Enter **`show startup-config`** (abbreviated: **`sh start`**) at the router prompt.
Explanation: This step confirms that the router startup configuration will not be available upon restarting of the router.

3. What does the router show after this command is entered?

Step 10 - Restart the router.

Task: Enter **`reload`** at the router prompt.

Explanation: The **`reload`** command will reboot the router. When asked to proceed with the reload, enter **Y** and press the Return/Enter key. Note that the router displays the message: "**Notice: NVRAM invalid, possibly due to write erase.**" When prompted to enter the initial configuration dialog, type **N** and press the Return/Enter key. When prompted to terminate autoinstall type Y and press enter. Press the Return/Enter key one additional time.

4. What does the prompt look like?

Step 11 - Reconfigure the router from the text file you saved.

Task: Use the send file command in HyperTerminal to copy the new configuration.
Explanation: The cleaned up version of the router configuration file from step 7 will be copied into the area of memory known as the clipboard.

In HyperTerminal, enter the command **`enable`** to change in to Privileged EXEC mode.

5. Why was a password not required?

Enter global configuration mode by entering the command **`configure terminal`** (abbreviated **`config t`**). Click on Transfer/Send/Text File. Select the file you saved in step 4. Each line in the text file will be entered for you, as though you were typing them yourself.

6. What does the router prompt change to?

---

7. What command changes the router prompt?

Press and hold the **Control** key then press the **Z** key to exit global configuration mode.

Step 12 - Save new configuration file.

Task: Use the command **`copy running-config startup-config`** (abbreviated: **`copy run start`**) to save the newly created router configuration.
Explanation: The **`copy running-config startup-config`** command copies the active router configuration from **RAM** into **NVRAM**.

Verify that the running configuration is correct by using the **`show running-config`** command (abbreviated **`show run`**). Enter the command **`copy start run`** at the router prompt.

Step 13 - Verify new configuration.

Task: Use the command **`reload`** command to restart the router.
Explanation: Verify that the new configuration has been saved to NVRAM by restarting the router.

Enter the command **`reload`**. When prompted to confirm press **`Y`**, this will restart the router. Once the router restarts, press the Return/Enter key again.

8. What does the router prompt look like?

_____

Lab 6.1.4 Router Configuration TFTP - Overview

Estimated time: 20 min.

Objectives:

- Copy a router configuration file to a TFTP server.
- Configure a router from a TFTP server.

Background:

In this lab we will use a TFTP (Trivial File Transfer Protocol) server to save a copy of the router configuration file. We will also configure the router from the TFTP server. Using a TFTP server is an excellent way to keep backup copies of configuration files for routers and other network equipment, such as switches. Additionally, IOS images can be stored on a TFTP server. A TFTP server is simpler to use than a standard FTP server. TFTP does not require a user to have a password, or to navigate between directories. For this reason, it is important to have the TFTP server secure (i.e. not available to the general public). TFTP uses UDP rather than TCP like a standard FTP server does. TFTP is a very basic file transfer utility and does not require the guaranteed delivery services of TCP. The TFTP "server" can be a file server, a workstation or even a Cisco router and it must have the TFTP utility installed and running. You can download the Cisco TFTP server at no cost from the web site listed below.

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal program that is configured to connect to the router. Verify that the Cisco TFTP server is installed on a server accessible by the router. You may want to review Chapter 13 in the Cisco Networking Academy First-Year Companion Guide and review semester 2 online curriculum Chapter 6 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`copy running-config`**
- **`erase startup-config`**
- **`reload`**

Resources Required:

- PC with monitor, keyboard, mouse, and power cords, etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal program configured for router console access
- PC connected to the router console port with a roll-over cable
- The TFTP installed and running on a workstation accessible from the router you are working on.

NOTE:

If the TFTP server is not installed you can download it from the web site listed below and copy it to the workstation which will act as the TFTP server. Click on the downloaded file to install.

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Free Cisco TFTP Server (Win 9x version)
TFTP Command Syntax

Notes:

Step 1 - Login to the router

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Enter the Privileged EXEC mode.

Task:

a. From user EXEC mode, enter privileged EXEC mode using the **enable** command.
b. Enter the enable password of **class**.

Explanation: Enter the enable mode from the User EXEC mode.

Step 3 - Verify connectivity to TFTP server.

Task: Enter **`ping xxx.xxx.xxx.xxx`** (the IP address of the workstation running the TFTP server.
Explanation: Ensure that you can reach the TFTP server from the router.

If you cannot, you will first need to check the connections and then check the configurations of the routers in the lab to ensure you can reach the TFTP server. Verify that your workstation has the TFTP server installed and that it is running.

Step 4 - Copy configuration file to TFTP server.

Task: Enter the command **`copy running-config tftp`** (abbreviated: **`copy run tftp`**).
Explanation: Start the process of copying the router running configuration to the TFTP server.

Enter the command **`copy running-config tftp`** (abbreviated: **`copy run tftp`**). When prompted for the remote host, enter the IP address you verified in step 3 and press the Return/Enter key. When prompted for the configuration file to write, the default is the router's name, followed by a dash and the word confg (e.g. **LAB-A-confg**). Accept this name by pressing Return/Enter, or type in a new name and press Return/Enter.

1. What is the name of the configuration file you are writing on the TFTP server?
(Answers will vary)

_____

Confirm writing the configuration file to the TFTP server by pressing Return/Enter. You will notice exclamation marks appear on the screen, showing the progress of the TFTP file copy process.

Step 5 - Erase the `startup configuration`.

Task: Enter command **`erase startup-config`** (abbreviated: **`erase start`**) at the router prompt.
Explanation: The **`erase startup-config`** command deletes the contents of **NVRAM**.

Caution should be used with this command since the router executes it without prompting for confirmation.

Step 6 - Confirm that startup configuration has been deleted.

Task: Enter **`show startup-config`** (abbreviated: **`show start`**) at the router prompt.
Explanation: This step confirms that the router startup configuration will not be available upon restarting of the router.

2. What does the router show after this command is entered?

_____

Step 7 - Restart the router.

Task: Enter **`reload`** at the router prompt.
Explanation: The **`reload`** command will reboot the router.

When asked to proceed with the reload, enter **Y** and press the Return/Enter key. Note that the router displays the message: "**Notice: NVRAM invalid, possibly due to write erase**". When prompted to enter the initial configuration dialog, type **N** and press Return/Enter. When prompted to terminate autoinstall, type **Y** and press Return/Enter. Press Return/Enter once again.

3. What does the prompt look like?

_____

Step 8 - Enter the `Privileged EXEC mode`.

Task: From user EXEC mode, enter privileged EXEC mode using the **`enable`** command.
Explanation: Enter the enable mode from the User EXEC mode.

Note that since the configuration has been erased, no password is required.

Step 9 - Reconfigure the router Ethernet interface.

Task: Manually reconfigure the IP address and subnet mask of the interface (E0 or E1) used to transfer the backup configuration file to the TFTP server.
Explanation: The router lost its configuration file when NVRAM was erased and the reloaded. Configuration of the interface is necessary to re-establish a connection to the TFTP server.

Step 10 - Copy the backup configuration file from TFTP server.

Task: Enter the command **`copy tftp running-config`** (abbreviated: **`copy tftp run`**).
Explanation: Start the process of copying the router running configuration to the **TFTP** server.

Enter the command **`copy tftp running-config tftp`**. When prompted for the remote host, press Return/Enter to indicate the host configuration file. When prompted for the remote host, enter the IP address you verified in step 3 and press Return/Enter. When prompted for the configuration file to write, the default is the router name, followed by a hyphen and the word confg (e.g. **LAB-A-confg**). Accept this name by pressing Return/Enter, or type in a new name and press Return/Enter or type the name you used in Step 4 and press Return/Enter. Confirm copying the configuration file from the **TFTP** server by pressing Return/Enter. When the process is complete, the router indicates the amount of **RAM** used for the configuration file and the total amount of **RAM** available on the router.

Step 11 - Save new configuration file.

Task: Use the command **`copy running-config startup-config`** (abbreviated: **`copy run start`**) to save the newly created router configuration.
Explanation: The **`copy running-config startup-config`** command copies the active router configuration from **RAM** into **NVRAM** as a backup.

Verify that the running configuration is correct by using the **`show running-config`** command (abbreviated: **`show run`**). Enter the command **`copy start run`** at the router prompt.

Lab 6.2.1 Basic router configuration - Overview

Estimated time: 45 min.

Objectives:

- Use the Router Configuration Mode to configure the routing protocol.
- Configure router identification (name).
- Configure a message of the day (motd) banner.
- Use the Interface Configuration Mode to enter a description for an interface.

Background:

In this lab you will use the router global configuration mode and enter one-line commands that change the entire router. The router prompt in global configuration mode is: "**Router-name(config)#**". Other configuration modes will be used for multiple command lines and detailed configurations as in configuration of interfaces. When working with the interfaces, the router prompt looks like "**Router-name(config-if)#**". You will also configure a message-of-the-day banner using the **`banner motd`** command in global configuration mode and enter descriptions for the interfaces on the router in interface configuration mode.

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal program that is configured to connect to the router. You may want to review Chapter 15 in the Cisco Networking Academy First-Year Companion Guide and review Semester 2 Online curriculum Chapter 6 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`Enable`**
- **`Show running-config`**
- **`Show startup-config`**
- **`Configure terminal`**
- **`Hostname`**
- **`Banner motd`**
- **`Interface`**
- **`Description`**
- **`Reload`**

Resources Required:

- PC with monitor, keyboard, mouse, and power cords, etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal PE program configured for router console access
- PC connected to the Router console port with a roll-over cable

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary

Notes:

Step 1 - Login to the router

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Enter privileged mode.

Task:

a. Enter **enable** (abbreviated " **en** ") at the command prompt.
b. Enter the password of **class**.

Explanation: You use the **enable** command to enter privileged EXEC mode.

1. What is the router command to view the current running configuration?

Step 3 - Show the active configuration file.

Task: Enter **show running-config** (abbreviated " **sh run**") at the router prompt.
Explanation: The router will display information on how it is currently configured from the file that is loaded in **RAM** (Random Access Memory).

2. Compare hostname in the running-config with the router prompt. Are they the same?

Step 4 - Show the backup configuration file.

Task: Enter **`show startup-config`** (abbreviated " **`sh start`**") at the router prompt.
Explanation: The router will display information on the backup configuration file stored in NVRAM (Non-Volatile RAM).

3. Is the hostname the same as the router prompt?

Step 5 - Enter `global configuration mode`.

Task: Enter **`configure terminal`** (abbreviated " **`config t`**") at the router prompt.
Explanation: To configure the router you must enter the global configuration mode. Notice how the router prompt has change after this command.

4. What does the router prompt look like?

Step 6 - Enter the `help` command

Task: Enter the help command by typing (**?**) at the router prompt.
Explanation: The router will respond with all commands available in global configuration mode.

5. Is hostname one of the command options?

Step 7 - Enter the help command for hostname

Task: Enter help command for hostname by entering **`hostname ?`** at the router prompt.
Explanation: You can get help with any command by entering the command followed by a space and a (**?**).

6. What did the router respond back with?

Step 8 - Change the hostname of the router.

Task: Enter **hostname** and ***your first name*** at the router prompt.
Explanation: This command will change the router hostname to your first name.

7. Did the router prompt change to the new hostname?

Step 9 - Show the active configuration file.

Task:

a. Enter **`exit`** at the router prompt to return to the privileged mode prompt
b. Enter **`show running-config`** at the router prompt.

Explanation: To check the running configuration we first have to exit out of global configuration mode using **`exit`**, then we will be at a privilege mode prompt and we can issue the **`show running-config`** command.

> **NOTE:**
>
> The configuration change (host name) you just made is in effect until the router is rebooted or reloaded.

8. What is the router hostname?

_____

Step 10 - Show the backup configuration file.

Task: Enter **`show startup-config`** at the router prompt.
Explanation: The router will display information on the backup configuration file stored in NVRAM.

9. Is the hostname the same as the router prompt?

_____

Step 11 - Enter global configuration mode.

Task: Enter **`configure terminal`** (abbreviated: **`config t`**) at the router prompt.
Explanation: To configure the router you must enter the global configuration mode. Notice how the router prompt has changed after this command.

Step 12 - Enter a message of the day

Task: Enter **`banner motd`** #This is the Message Of The Day# at the router prompt.
Explanation: This command will create a Message of the day banner that will display when someone logs into the router.

Note that the message is bracketed by # which tells the router the start and stop of the message.

Step 13 - Show information about the active configuration file.

Task:

a. Enter **exit** at the router prompt.
b. Enter **show running-config** at the router prompt.

Explanation: To check the running configuration you first have to exit out of global configuration mode using exit, then you will be at a privilege mode prompt and can issue the **show running-config** command.

NOTE:

The configuration change you just made is in effect until the router is rebooted or reloaded.

10. What did the router say the message of the day is?

_____

Step 14 - Log out of the router

Task: Enter **exit** at the router prompt.
Explanation: To exit the router you can use either **exit** or **logout** (or **ex** for short).

Step 15 - Log on to router

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 16 - Enter the privileged mode.

Task:

a. From user EXEC mode, enter privileged EXEC mode using the **enable** command.
b. Enter the enable password of **class**.

Explanation: Enter the enable mode from the User EXEC mode.

Step 17 - Show the active configuration file.

Task: Enter **show running-config** at the router prompt.
Explanation: The router will display information on how it is currently configured.

11. Is there a description name for interface serial0?

_____

Step 18 - Enter `global configuration` mode.

Task: Enter **`configure terminal`** at the router prompt.
Explanation: To configure the router you must enter the global configuration mode.

Notice how the router prompt has change after this command.

Step 19 - Enter `interface configuration` mode.

Task: Enter **`interface serial0 (int s0)`** at the global configuration prompt.
Explanation: Entering **`interface serial0`** at the global configuration prompt will allow you to change the configuration for serial0.

12. What does the router prompt look like in interface configuration mode?

_____

Step 20 - Enter the `help` command.

Task: Enter **?** at the router prompt.
Explanation: The router responds with a list of available commands to configure interface serial0.

Step 21 - Get help for the "description" command.

Task: Enter **`description ?`** at the router prompt.
Explanation: You can get help with any commands at any time using the **?** command.

Step 22 - Enter a description for interface serial0.

Task: Enter **description *any text you want up to 80 characters*** at the router prompt.
Explanation: This will enter a description for interface serial0.

Step 23 - Exit configuration mode.

Task:

a. Enter **`exit`** at the interface configuration mode.
b. Enter **`exit`** at the global configuration mode.

Explanation: The first exit command will exit you out of interface configuration mode and the second will exit you from the global configuration mode.

Notice how the router prompt has changed after each exit command.

Step 24 - Show the active configuration file.

Task: Enter **`show running-config`** at the router prompt.
Explanation: The router will display information on how it is currently configured.

13. What is the description for interface serial0?

_____

Step 25 - Show the `backup configuration` file.

Task: Enter **`show startup-config`** at the router prompt.
Explanation: The router will display information on the backup configuration file stored in NVRAM.

14. Is the interface serial0 description the same as in step 22?

_____

Step 26 - Reload the router

Task: Enter **`reload`** at the router prompt. When prompted to save changes answer **NO**.
Explanation: All the changes that we made to the router were in effect in the active configuration, when we reload the router the router reloads from the backup configuration file. If you wanted to keep the changes you would have to use a command to copy the running configuration to the backup configuration file.

15. What is the command to copy the current running configuration to the backup (startup) configuration?

_____

Lab 6.2.5 Router interface config. - Overview

Estimated time: 45 min.

Objectives:

- Use the Interface Configuration Mode to configure interfaces.
- Configure IP address assignments for router interfaces.
- Configure subnet mask assignments for router interfaces.
- Copy the running configuration to the backup configuration.

Background:

In this lab you will use the router interface configuration mode to configure an IP address and subnet mask for each router interface. You will verify that Layer 3 connectivity is functioning by using the **ping** command. The **show running-config** command will help to make sure the changes you have made are what were intended. You will then save the running configuration to the backup configuration.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard 5-router lab available. The NVRAM of the router you will be configuring should be erased. At the start of this section the instructor or lab assistant should log on to each router in the enable exec mode and issue the **erase startup-config** command; then issue the **reload** command. This will force the routers to come up with a blank configuration. The IP configuration for the associated workstation should also be changed so that it is incorrect. The answer section includes examples of the detailed command sets that the students will have to master. The instructor will review your configuration when finished.

Prior to starting the lab you will need to connect a PC workstation with HyperTerminal to a router using the routers console Interface with a roll-over cable. This lab should be done at the router console station. You may want to review Chapter 17 in the Cisco Networking Academy First-Year Companion Guide and review Semester 2 Online curriculum Chapter 6 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **Enable**
- **Show running-config**
- **Show startup-config**
- **Configure terminal**
- **Interface**
- **Copy**
- **Reload**
- **Exit**

Resources Required:

- PC with monitor, keyboard, mouse, power cords, etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC

- HyperTerminal PE program configured for router console access
- PC connected to the Router console port with a roll-over cable

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Beginning IP for new users

Notes:

_____

_____

_____

_____

_____

Step 1 - Log on to router.

Explanation: Connect to the router and log in. Enter the password **cisco** if prompted.

Step 2 - Enter privileged mode.

Task:

a. Enter **enable** (abbrev. "**en** ") at the command prompt.
b. Enter the password of **class**.

Explanation: You use the **enable** command to enter privileged EXEC mode.

Step 3 - Show the active configuration file.

Task: Enter **show running-config** (abbrev. " **sh run**") at the router prompt.
Explanation: The router will display information on how it is currently configured.

1. Fill in the following table with the information from the standard 5-router lab diagram.

Interface	IP Address	Subnet Mask

Step 4 - `ping` all interfaces on the router.

Task: Enter **`ping xxx.xxx.xxx.xxx`** at the router prompt. (xxx.xxx.xxx.xxx equals an IP address)
Explanation: Using **`ping`** will test Layer 3 connectivity.

> **NOTE:**
>
> If the other end of the WAN serial link (to the next router) is not configured correctly or the other router is not powered on you may not get a good ping result.

2. Did all the interfaces ping successful?

Step 5 - Enter `global configuration mode`.

Task: Enter **`configure terminal`** (abbrev. "**`config t`**") at the router prompt.
Explanation: To configure the router you must start in global configuration mode. Notice how the router prompt has change after this command.

3. What does the router prompt look like?

Step 6 - Enter `interface configuration mode`.

Task: Enter **`interface serial0`** (abbrev. "**`int s0`**") at the global configuration prompt.
Explanation: Entering **`interface serial0`** at the global configuration prompt allows you to change the configuration for serial0.

4. What does the router prompt look like?

Step 7 - Configure IP address for `serial0`.

Task:

a. Enter **`IP address xxx.xxx.xxx.xxx yyy.yyy.yyy.yyy`** at the router interface mode prompt. xxx.xxxx.xxx.xxx is the IP address and yyy.yyy.yyy.yyy is the subnet mask for serial0. Use the IP address and subnet mask from the standard 5-router lab setup.

Explanation: This command will set the IP and subnet mask for serial0

Task:

b. Enter **clockrate 56000** to set the DCE clock rate for the WAN link

Explanation: The clock rate must be set on the DCE (female) connection.

Step 8 - Exit from interface configuration mode.

Task: Enter **exit** at the router prompt.
Explanation: When you type **exit** at the interface configuration mode it will back you up to a global configuration prompt.

5. What does the router prompt look like?

_____

Step 9 - Exit from global configuration mode.

Task: Enter **exit** or and hold the control key and then press the z key (Ctrl-z).
Explanation: When you type exit or enter the Ctrl-z the router will place you in privileged mode.

6. What does the router prompt look like?

_____

Step 10 - Show the active configuration file.

Task: Enter **show running-config** at the router prompt.
Explanation: The router will display information on how it is currently configured. Notice any changes you entered will show up.

7. What did the router say the IP address and subnet mask was for serial0?

_____

Step 11 - Test layer 3 connectivity using ping.

Task: Enter **ping xxx.xxx.xxx.xxx** where xxx.xxx.xxx.xxx is an IP address of serial0 at the router prompt.

Explanation: This will test serial0 and make sure it is up and running.

> **NOTE:**
>
> If the other end of the WAN serial link (to the next router) is not configured correctly or the other router is not powered on you may not get a good ping result.

Step 12 - Copy the running configuration to the backup configuration.

Task: Enter **`copy running-config startup-config`** at the router prompt.
Explanation: This will copy the running configuration to the backup configuration. The next time the router is turned on or reloaded it will load from the backup configuration.

Step 13 - Repeat this lab with all interfaces identified in step 3 (clockrate is set on S0 only).

8. What command will show how many and what kind of interfaces are on your router?

_____

Step 14 - Reloading the router's configuration.

Task: Enter **`reload`** at the router prompt.
Explanation: This command will reload the router from the backup configuration.

Step 15 - Show information about the `active configuration` file.

Task: Enter **`show running-config`** at the router prompt and compare the results with step 3.
Explanation: The router will display information on how it is currently configured.

Step 16 - Exit the router.

Lab 6.4.1 Router configuration challenge - Overview

Estimated time: 30 min.

Objectives:

- Demonstrate your ability to configure a router for a remote office.
- Configure IP address assignments for router interfaces.
- Configure subnet mask assignments for router interfaces.
- Use **`ping`**, **`traceroute`** and **`tracert`** to test connectivity between devices.

Background:

You and your group are administrators of a LAN. Due to the rapid expansion of this company, you need to link the headquarters (your group's router) to the rest of network. You must link up the networks via the serial ports, which means that your group is responsible for only your router's connections. Before starting this lab the, Lab Assistant or the Instructor should erase the running configuration and the startup configuration for Lab-A only and make sure that the rest of the routers are configured with the standard lab setup. You will also need to verify your workstation IP configuration so you can test the connectivity between workstations and routers.

Tools / Preparation:

All lab work is done through the HyperTerminal program that is configured to connect to the router. This lab should be done at the router console station on Lab-A. You may want to review Chapter 15 in the Cisco Networking Academy First-Year Companion Guide and review semester 2 online curriculum Chapter 6 prior to starting this lab. Work individually or in teams.

Resources Required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 3 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers

Terms and acronyms
IP routing protocol IOS command summary

Notes:

Step 1 - Connect Lab-A router to the rest of the network.

Connect to the router. The router should have no configuration prior to starting this lab. Use the standard network diagram to configure the Lab-A router. You can configure the router anyway you prefer. Make sure the workstations are configured with an IP address, Subnet Mask, and a Default Gateway.

NOTE:

If you are using the setup command you will need to add additional commands, setup will only do a basic configuration. If you need help you can type ? at any time to enter the help facility.

1. Perform the following tests to verify that you have configured Lab-A and the workstation correctly. If any of the tests fail you must troubleshoot the problem with your router or workstation and document your results in the table below. (answers will vary)

Test	Result OK?	Problem
Ping Lab - B		
Ping Lab - C		
Ping Lab - D		
Ping Lab - E		
Trace route to LAB-E		
Ping a workstation on LAB-B		

Ping a workstation on LAB-C		
Ping a workstation on LAB-D		
Ping from a workstation on LAB-A to a workstation on LAB-E		
Trace route from a workstation on LAB-A to a workstation on LAB-E		

Lab 6.4.2 Cisco configmaker - Overview

Estimated time: 30 min.

Objectives:

- Use Cisco ConfigMaker to configure a router.
- Draw a map of a network using Cisco's ConfigMaker.
- Print a configuration file created by ConfigMaker.

Background:

This lab is intended to help you become familiar with Cisco ConfigMaker. Cisco ConfigMaker is an easy-to-use Windows 95/98/NT application that configures Cisco routers, switches, hubs, and other devices. Using a graphical user interface (GUI), you draw your network and then Cisco ConfigMaker creates the Cisco IOS configuration files for the devices on your network. In addition, you can use Cisco ConfigMaker as an off-line tool. You can draw and configure your entire network without having the devices on-hand until you are ready to deliver the configuration files to them. This software has many options and you are encouraged to "play" with the configuration of the network. This lab will take you through a basic configuration to familiarize you with the software

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. You will need to download the latest version of Cisco ConfigMaker and install the program on the computer workstation. You will need to have at least 3 routers available. All lab work is done through the HyperTerminal program that is configured to connect to the router. Work individually or in teams.

> **NOTE:**
>
> The routers must be running IOS version 11.2 or later in order to deliver the configuration files.

Resources Required:

- PC workstation with Windows operating system and HyperTerminal installed.
- Cisco ConfigMaker - latest version · IOS version 11.2 or later.
- Two Cisco routers - model 1600 series or 2500 series each with 1 serial and 1 Ethernet Interface.
- One Cisco router - model 1600 series or 2500 series with 2 serial and 1 Ethernet Interface.
- Two Ethernet hubs - 10BASE-T, 4 to 8 ports (Use three hubs if switch is not available).
- One Ethernet switch (Cisco Catalyst 1900 or similar).
- Three console cables to connect workstation directly to router console port.
- Three Sets of V.35 WAN serial cables (male/female) to connect from router to router.

- Six CAT5 Ethernet cables wired straight through.

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Cisco ConfigMaker information and download

Notes:

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_____

Step 1 - Download and install Cisco ConfigMaker.

Explanation: Check the computer workstation to make sure that the latest version of Cisco ConfigMaker is installed. If it is not installed or you do not have the latest version then you will have to download it from www.cisco.com and install it (web site URL is listed in the Overview section of this lab). There is no cost for the software.

Step 2 - Run Cisco ConfigMaker and start tutorial.

Task: Double click on the Cisco ConfigMaker icon.
Explanation: This will launch the ConfigMaker program and start the tutorial automatically if you choose. You may also run the tutorial at a later time by clicking on the tutorial icon on the tool bar.

Step 3 - Add routers to you network diagram.

Task: Under Devices, click on the Routers folder and add the routers on your lab setup.
Explanation: Once you have selected the correct model number of the router that you are adding, place the router where you would like it in the network diagram area by dragging it to the Network Diagram area. You will be prompted for configuration information.

1. What other router series can you configure with ConfigMaker?

_____

Step 4 - Configure the router.

Task: Follow the prompts to configure the router.
Explanation: First you will be asked for the name of the router. Enter **Lab-A** and click on next. Then you assign login and enable secret passwords to the router. Enter **cisco** as the password and **class** as the enable, then click on next. Now you need to tell the router what protocol you are going to use, select **TCP/IP** and click next then finish.

Step 5 - Repeat step 3 and 4 to add other routers to your network diagram.

Explanation: Add at least 2 more routers from your lab setup to your network diagram.

Step 6 - Add connections to the routers.

Task: In the connections window click on HDLC and then on Lab-A then to the connecting device (Lab-B).
Explanation: Once you have added the HDLC connection from Lab-A to Lab-B the HDLC wizard opens up. Click on next. Now you will be asked what serial interface you want to use for this connection. Use Serial0 then click on next. Now you are asked for addressing information for this interface. Enter IP address and subnet mask, click on next. Now ConfigMaker will ask you to supply information about the router you are connected too (Lab-B). Select interface Serial1 for Lab-B and enter the IP address, then click on next. Now you will have an opportunity to create a backup connection. For this lab choose "no backup" then click on next then finished. You can click on the routers and rearrange them if desired.

2. What other connections can you configure using ConfigMaker?

_____

_____

Step 7 - Repeat step 6 to add connections from Lab-B to Lab-C.
Step 8 - Check / Add to configuration.

Task: Double click on Lab-A router in your network diagram.
Explanation: This will allow you to add or change the configuration for that router. Click on the IOS Configuration tab. Compare the IOS configuration for interface Serial0 with the output from the **`show running-config`** command listed in Lab 4.2.4 - Router Show Commands - Answers section.

3. What command was missing from the ConfigMaker's IOS Configuration for interface S0?

_____

Step 9 - Append configuration commands.

Task: From Lab-A Properties under IOS Configuration tab click on **Add / Modify IOS commands** button.
Explanation: This window will let you enter additional commands for the router.

As you probably noticed from step 8 that on Lab-A Serial0 is the DCE and should be providing the "clock rate". Any commands will be added to the bottom of the configuration list.

4. What commands do you need to add to the router to add clocking for interface S0?

Step 10 - Deliver the IOS commands to the router.

Task: Highlight the router you want to load the IOS configuration into, and then click on the Deliver button.
Explanation: As long as you have a connection to the router to which you are trying to load the IOS configuration, ConfigMaker will attempt to load the IOS config. If there is a problem or an error ConfigMaker will tell you and you can fix the problem and then "Deliver" the IOS configuration again.

Step 11 - Print your network diagram and router configuration.

Task: Click the File menu and the click Print Network or Print All.
Explanation: You can print a graphical diagram of the network you have drawn so far or click on **Print Preview** to see what it will look like before printing it. Print All will print the network diagram and a listing of the configuration file for each router.

Step 12 - Save the router configuration to a text file.

Task: Right-click on the router, click IOS Configuration and then click **File/Save As**.
Explanation: You may wish to save a copy of the configuration file that ConfigMaker generates for later editing with a text editor. You can name the file and it will have a .CFG extension. You can edit it with Notepad. You can also print the config file from here or send it to a router.

A sample ConfigMaker file for router Lab-A is shown in the answer section of this lab.

Lab 6.4.3 Router config. web browser - Overview

Estimated time: 15 min.

Objectives:

- Configure a router as an HTTP server to accept configuration requests via a web browser.
- Learn what settings on a router can be configured via a web browser.

Background:

With Cisco IOS version 11.0 or newer, the IP HTTP server command allows the router to act as a limited HTTP (Hyper Text Transfer Protocol) web server. There are no graphics, but rather a series of text color screens that allow the administrator to modify the configuration and view information about the router. The browser interface to the router supports mouse control and makes it easier to do some tasks without requiring as much knowledge of the CLI (Command Line Interface). The CLI is available once in the browser mode. It is possible to use a browser interface when accessing Cisco switches as well as routers

A web browser is more likely to be available on a client computer than a Telnet program. It may be easier in some instances to check on the status of a router and do minor configuration from a web browser. Since it is relatively easy for someone outside your organization to find out what the IP address of your router is, you may not want to leave this function enabled at all times.

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. The workstation will need a current version of a web browser (Internet Explorer or Netscape Navigator) installed. There must be Ethernet or WAN connectivity between the workstation and the router as well as a console connection. The browser function cannot be used with the console connection but it is necessary to configure the router to allow a browser connection first using the console connection. You may want to review Chapter 13 in the Cisco Networking Academy First-Year Companion Guide and review semester 2 online curriculum Chapter 6 prior to starting this lab. Work individually or in teams. Be familiar with the following command:

- **`ip http server`**

Resources Required:

- PC with monitor, keyboard, mouse, power cords, etc.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal PE program configured for router console access
- PC connected to the Router console port with a roll-over cable
- PC connected to the same hub or switch as the router
- A web browser (Internet Explorer or Netscape Navigator) installed on the workstation. You must have an Ethernet connection to the router you wish to configure

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary
Command syntax of ip http

Notes:

Step 1 - Login to the router.

Task: Connect to the router and login. Enter the password **`cisco`** if prompted.

Step 2 - Enter the Privileged EXEC mode.

Task:

a. From user EXEC mode, enter privileged EXEC mode using the **`enable`** command.
b. Enter the enable password of **`class`**.

Explanation: Enter the enable mode from the User EXEC mode.

Step 3 - Enter global configuration mode.

Task: Enter the command **`configure terminal`** (abbreviated: **`config t`**).
Explanation: Global configuration mode allows you to change settings that affect the router.

Step 4 - Enable the HTTP server function.

Task: Enter the **`ip http server`** command. Press and hold the control key and press the z key (Ctrl-z) to exit global config mode.
Explanation: This command allows the router to act as a limited HTTP server on the default HTTP port 80.

Step 5 - Access the router via the web browser.

Task: Activate the web browser on your workstation and enter the IP address of the router Ethernet port into your browser address window.
Explanation: By entering the IP address of your router Ethernet interface, you will connect to the router as an HTTP client. The HTTP server, which you previously activated in the router, will respond to the browser requests.

1. What is the IP address of the Ethernet port? (Answers will vary)

_____

When prompted for a user name and password, the user name field may be left blank: enter **`class`** for the password.

2. What options are available? (Note 2500 series routers do not have the "**ClickStart**" option)

Step 6 - Examine the available options.

Task: Click on each of the options and make notes in your engineering journal.
Explanation: Note the Help Resources listed on the bottom half of the router home page.

3. Which option on the router home page has the most sub-options?

_____

Lab 7.1.3 IOS Image boot

Estimated time: 20 min.

Objectives:

- Display information about the Cisco IOS Image (software) that is currently running
- Determine where the IOS is booting from
- Check the amount of RAM, Flash and NVRAM memory the router has
- Check the IOS image and Flash for space used and available
- Document the parts of the IOS image file name
- Check and document the configuration register settings related to boot method
- Document a fallback boot sequence

Background:

In this lab you will gather information on the version of IOS software that is currently running on the router. You will also check the configuration register values to see where the router is currently configured to boot from. Use the **`show flash`** command to gather information about the flash memory and what files and how much memory is free. You will also document the commands necessary to change the config register setting and the boot system commands necessary to define a fallback boot source sequence in case the IOS image in flash is missing or corrupted.

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. This lab should be done at the router console station. You may want to review Chapter 16 in the Cisco Networking Academy First-Year Companion Guide and review semester 2 online curriculum Chapter 7 prior to starting this lab. Work individually or in teams. You should also be familiar with the following commands:

- `enable`
- `show running-config`
- `show startup-config`
- `show flash`
- `show version`
- `boot system`
- `config-register`
- `copy`

Resources Required:

- PC with monitor, keyboard, mouse, power cords, and so on.
- Windows operating system (Win 95, 98, NT or 2000) installed on PC
- HyperTerminal program configured for router console connection
- PC connected to the Router console port with a roll-over cable

Web Site Resources:

- Routing basics
- General information on routers
- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

Step 1 - Login to the router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Enter privileged mode.

Task:

a. Enter **enable** at the command prompt.
b. Enter the password of **class**.

Explanation: You use the **enable** command to enter privileged EXEC mode

Step 3 - Show information about the backup configuration file.

Task: Enter **show startup-config** at the router prompt.
Explanation: The router will display information on the backup configuration file stored in NVRAM.

1. Is there any indication of the configuration register setting?

Step 4 - Display IOS version and other important information.

Task: Enter **show version** command at the router prompt.
Explanation: The router will return information about the IOS that is running in RAM.

2. With the information that the router returns, answer the questions below:

a. What is the IOS version and rev level?

b. What is the name of the system image (IOS) file?

c. Where was the router IOS image booted from?

d. What type of processor (CPU) and how much RAM does this router have?

e. What kind of router (platform type) is this?

f. The router backup configuration file is stored in Non-Volatile Random Access Memory (NVRAM). How much NVRAM does this router have?

g. The router operating system (IOS) is stored in Flash memory. How much flash memory does this router have?

h. What is the Configuration register set to? What boot type does this setting specify?

3. Assuming the config-register was currently set to 0x2102, write the configuration mode commands to specify that the IOS image should be loaded from:

a. Flash:

b. ROM monitor:

c. ROM:

4. If the router were in ROM monitor mode, what command would manually boot the Cisco IOS software?

Step 5 - Show information about the Flash memory device.

Task: Enter **`show flash`** at the router prompt.
Explanation: The router will respond with information about the flash memory and what IOS image file(s) are stored there.

5. Document the following information.

a. How much flash memory is available and used?

b. What is the file that is stored in flash memory?

c. What is the size in bytes of the flash memory?

6. What part of the IOS file name igs-j-l.111-5 identify the following:

a. Platform on which the image runs.

_____

b. Special capabilities.

_____

c. Where the image runs and whether it has been zip compressed.

_____

7. To specify a fallback boot sequence, write the configuration command to specify that the IOS image should be loaded from:

a. Flash:

_____

b. A TFTP server:

_____

c. ROM: Will this be a full IOS image?

_____

8. To ensure that these commands are available for the router to use the next time it is restarted what command would you need to enter next?

_____

Lab 8.1.2 Router password recovery - Overview

Estimated time: 15 min.

Objectives:

- To learn the recovery procedure when a password is forgotten.

Background:

There will be circumstances where the password for a router needs to be reset. The password may have been forgotten or the network administrator may have left the company. The password recovery procedure requires physical access to the router because a directly connected console cable is used. Since password recovery methods are published on the Internet and in books, routers need to be in a secure location with physical access limited to authorized staff.

The version of HyperTerminal provided with Windows 95, 98, NT, and 2000 was developed for Microsoft by Hilgraeve. This version does not issue a "break" sequence as required for the Cisco router password recovery technique. An upgrade, known as HyperTerminal Private Edition (PE), is available free of charge for personal and educational use. Commercial use of the program requires registration with Hilgraeve. The program may be downloaded from the Hilgraeve web site listed in Web Site Resources below.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard five-router lab available. The NVRAM of the router you will be configuring should be erased. Before beginning the lab, the instructor or lab assistant should login to each router, enter the privileged EXEC mode, issue the erase startup-config command, and then issue the reload command. This will force the routers to come up with a blank configuration. The answer section includes examples of the detailed command sets that the students will have to master. The instructor will review the router configuration when finished.

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal PE program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal PE program that is configured to connect to the router. You may want to review Chapter 13 in the Cisco Networking Academy First-Year Companion Guide. Work individually or in teams. Be familiar with the following commands:

- `config-register`
- `show version`
- `configure terminal`
- `enable secret`

Resources Required:

- PC connected to the router console port with a roll-over cable

- Windows operating system (Win 95, 98, NT, or 2000) installed on PC
- HyperTerminal PE program configured for router console access
- PC connected to the router console port with a roll-over cable

Websites Sites Required:

- Routing basics
- General information on routers
- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary
- Hilgraeve HyperTerminal PE download
- IOS password encryption facts

Notes:

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Step 1 - Login to a router.

Explanation: Connect to the router and login. Enter the password **`cisco`** if prompted.

Step 2 - Record the configuration register setting.

Task: Enter the command **`show version`** (abbreviated **`show ver`**).
Explanation: This displays the current configuration register setting, along with other information.

1. What is the current configuration register setting?

_____

Step 3 - Restart the router.

Task: Turn off the router for a short period of time and turn it back on again.
Explanation: When the router is restarting, the boot up sequence can be interrupted.

Step 4 - Interrupt the boot up sequence.

Task: Within 60 seconds of turning the router back on, press and hold the **Control** key, then press the **Break** key.
Explanation: A break character is sent to the router, interrupting the boot up sequence.

Step 5 - Change the configuration register.

Task: Enter the commands to change the configuration register.
Explanation: The configuration register is changed to tell the router to ignore the configuration file in **NVRAM** on the next startup. The procedure varies depending on the model of router.

A. 2500 series router:

The prompt will be **>** with no router name. Type **o/r 0x42** and press enter (lower case letter o, slash, lower case r, space, zero, lower case x, four, two). Type **i** and press enter to reload the router. Wait until the router has rebooted. Type **n** when prompted to enter initial configuration. Press enter to see the **router>** prompt.

B. 1600 series router:

The prompt will be **`rommon 1>`**. Type **config** and type **Y** when asked to change the configuration. Type **N** to all questions except **`ignore system config info`**. When you complete responding to the questions, you will be prompted to change the configuration again. Type **N**, then type **reset** to reload the router. Wait until the router has rebooted. Type **N** when prompted to enter initial configuration. Press enter to see the **router>** prompt.

Step 6 - Enter the privileged EXEC mode.

Task: From user EXEC mode, enter privileged EXEC mode using the **`enable`** command.
Explanation: Enter the enable mode from the user EXEC mode.

2. Why was no password required?

_____

Step 7 - Examine the configuration the router is using.

Task: Enter the command **`show running-config`** (abbreviated: **`sh run`**).
Explanation: Since the configuration registers were set to ignore the configuration file in step 5, the router has a minimal configuration.

Step 8 - Load the router configuration file.

Task: Type the command **`copy startup-config running-config`** (abbreviated: **`copy start run`**).
Explanation: The configuration file is loaded from **NVRAM** into **RAM**. This will allow us to view and/or modify the router passwords.

3. How does your router prompt change?

Step 9 - Look at passwords.

Task: Enter the command **`show running-config`** (abbreviated: **`sh run`**).
Explanation: Passwords that have been encrypted with the **`enable secret`** command show up as a series of letters, numbers and symbols. (e.g. 1miYV$i9OOuSBQBde5fzgS3tn8T0). Non-encrypted passwords are in plain text.

4. What passwords do you see?

Step 10 - Change passwords.

Task: Enter the commands to change the appropriate passwords.
Explanation: Passwords set using the **`enable secret`** command cannot be decrypted even with third-party software. The only option you have is to change the password to another value.

Go into global configuration mode by entering the command **`configure terminal`** (abbreviated: **`config t`**). Enter the command **`enable secret`** ***`newpassword`*** . Press and hold the Control key and press Z to exit out of global config mode. Type the command **`show running-config`** (abbreviated: **`sh run`**).

5. What passwords do you now see?

---

6. Has the encrypted password changed from the value in step 9?

NOTE:

For purposes of this lab, we will not be saving the router configuration with the new password. We need to change the password back to the value **`class`**. Enter global config mode by entering the command **`config t`**. Enter the command **`enable secret class`**, then press **Control Z** to exit global configuration mode. Save the new configuration by entering the command **`copy running-config startup-config`** (abbreviated: **`copy run start`**).

Step 11 - Change the configuration register.

Task: Examine the current status of the configuration register and change it back to its original value.
Explanation: The configuration register is still set to ignore the startup configuration contained in **NVRAM**. You need to change it back to its original value.

Enter the command **`show version`** (abbreviated **`sh ver`**).

7. What is the value of the configuration register?

Enter global config mode by typing the command **`config terminal`** (abbreviated: **`config t`**). Enter the command **`config-register 0x2102`**. (Note: use the original value you recorded in step 2). Press **Control Z** to exit global config mode. Enter the command **`sh ver`** to see the new value of the configuration register.

8. What is the new value of the configuration register?

Step 12 - Verify new password.

Task:

a. Enter the command **`reload`**.
b. Enter **Y** if prompted to save new configuration, and to proceed with reload.

Explanation: You need to verify that the new password you created in step 10 works. Enter privileged EXEC mode by entering the command **`enable`** (abbreviated: **`ena`**). Enter the password **class**. If you properly set the enable password, you should see the router prompt change. View the status of the configuration register by entering the command **`show version`** (abbreviated: **`sh ver`**).

9. Has the configuration register changed back to its original value you recorded in step 2?

Lab 8.2.1 Individual router config. - Overview

Estimated time: 30 min.

Objectives:

- Configure a router for the standard lab setup using only the lab diagram
- Configure the router using only the Command Line Interface (CLI)
- Configure workstation IP address settings to communicate with the router via Ethernet
- Prepare for Part A of the Final Exam (Timed Router Configuration)

Background:

In this lab you will configure one of the five lab routers from the command line. You should do this yourself, without the use of any notes. You may however, use the network topology. You may use the router help facility and the router diagram above. Your goal will be to configure the router as quickly as possible without errors. You will also configure the IP settings for one of the corresponding Ethernet attached workstations.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard five-router lab available. The NVRAM of the router you will be configuring should be erased. Before beginning the lab, the instructor or lab assistant should login to each router, enter the privileged EXEC mode, issue the **`erase startup-config`** command, and then issue the **`reload`** command. This will force the routers to come up with a blank configuration. The IP configuration for the associated workstation should also be changed so that it is incorrect. The answer section includes examples of the detailed command sets that the students will have to master. The instructor will review the router configuration when finished.

Worksheet

Step 1 - Review the physical connections on the standard lab setup.

Review the standard five-router lab diagram in the overview section of this lab and check all physical devices, cables and connections of the lab setup to familiarize yourself with them.

Step 2 - Console into the router.

Verify that you have a good console connection and that HyperTerminal is configured properly. The router should be booted with no startup configuration file in NVRAM.

Step 3 - Identify IP address information.

1. Fill in the table with IP interface information from the diagram for each of the five routers.

Cisco Lab Router IP Configuration (Answers from router diagram - your answers may vary)

Router Name	Lab-A	Lab-B	Lab-C	Lab-D	Lab-E
Model Number					
Interface E0 IP Address					
Interface E0 Subnet Mask					
Interface EI IP Address					
Interface EI Subnet Mask					
Interface S0 IP Address					
Interface SO Subnet Mask					
Interface SO + Clock Rate					
Interface SI IP Address				..	
Interface SI Subnet Mask					
Other Intfc(s)					

***Note: Clock rate must be set on the DCE end (S0) of the WAN link between routers.**

Step 4 - Configure the router via the console connection.

1. Select a router and time yourself. Configure the following information for each router: Host name, passwords, IP addresses for interfaces, routing protocol and associated network numbers, IP host lookup table. Repeat with other routers.

NOTE:

Make sure you copy the running configuration to the startup configuration when you are finished or you will lose the configuration upon next reboot.

Step 5 - Configure the workstation IP settings using the Control Panel / Network icon.

1. Configure the IP address, subnet mask and default gateway to be compatible with the router.

Step 6 - Test your configuration with `ping` and `telnet`.

1. From the PC DOS prompt, use the ping and telnet commands to test your configuration.

Listed below are the outputs from the **show running-config** command for all five routers in the standard lab setup. If you have problems configuring a particular router refer to these for help. Answers may vary depending on the router model number and exact configuration of your lab setup.

Router: LAB-A

```
LAB-A#show run

Building configuration...
Current configuration:
version 11.1
service udp-small-servers
service tcp-small-servers
hostname LAB-A
enable secret 5 $1$xT7v$9EC3X5IBHLwq2RehHNvWc0
interface Ethernet0
ip address 192.5.5.1 255.255.255.0
interface Ethernet1
ip address 205.7.5.1 255.255.255.0
interface Serial0
ip address 201.100.11.1 255.255.255.0
clockrate 56000
interface Serial1
no ip address
shutdown
router rip
network 192.5.5.0
network 205.7.5.0
network 201.100.11.0
ip host LAB-B 201.100.11.2 219.17.100.1 199.6.13.1
ip host LAB-C 199.6.13.2 223.8.151.1 204.204.7.1
ip host LAB-D 204.204.7.2 210.93.105.1
ip host LAB-E 210.93.105.2
ip host LAB-A 192.5.5.1 205.7.5.1 201.100.11.1
no ip classless
line con 0
password cisco
login
line aux 0
line vty 0 4
password cisco
login
!end
```

Router: LAB-B

```
LAB-B#show run

Building configuration...
Current configuration:
version 11.1
```



```
service udp-small-servers
service tcp-small-servers
hostname LAB-B
enable secret 5 $1$xT7v$9EC3X5IBHLwq2RehHNvWc0
interface Ethernet0
ip address 219.17.100.1 255.255.255.0
no mop enabled
interface Serial0
ip address 199.6.13.1 255.255.255.0
clockrate 56000
interface Serial1
ip address 201.100.11.2 255.255.255.0
interface BRI0
no ip address
shutdown
router rip
network 219.17.100.0
network 199.6.13.0
network 201.100.11.0
ip host LAB-B 201.100.11.2 219.17.100.1 199.6.13.1
ip host LAB-C 199.6.13.2 223.8.151.1 204.204.7.1
ip host LAB-D 204.204.7.2 210.93.105.1
ip host LAB-E 210.93.105.2
ip host LAB-A 192.5.5.1 205.7.5.1 201.100.11.1
no ip classless
snmp-server community public RO
line con 0
password cisco
login
line aux 0
line vty 0 4
password cisco
login
```

Router: LAB-C

```
LAB-C#show run

Building configuration...
Current configuration:
version 11.1
service udp-small-servers
service tcp-small-servers
hostname LAB-C
enable secret 5 $1$xT7v$9EC3X5IBHLwq2RehHNvWc0
interface Ethernet0
ip address 223.8.151.1 255.255.255.0
interface Serial0
ip address 204.204.7.1 255.255.255.0
clockrate 56000
interface Serial1
ip address 199.6.13.2 255.255.255.0
interface BRI0
no ip address
shutdown
router rip
```



```
network 223.8.151.0
network 199.6.13.0
network 204.204.7.0
ip host LAB-A 192.5.5.1 205.7.5.1 201.100.11.1
ip host LAB-B 201.100.11.2 219.17.100.1 199.6.13.1
ip host LAB-C 199.6.13.2 223.8.151.1 204.204.7.1
ip host LAB-D 204.204.7.2 210.93.105.1
ip host LAB-E 210.93.105.2
no ip classless
line con 0
password cisco
login
line aux 0
line vty 0 4
password cisco
login
!
```

Router: LAB-D

```
LAB-D#show run

Building configuration...
Current configuration:
version 11.1
service udp-small-servers
service tcp-small-servers
hostname LAB-D
enable secret 5 $1$xT7v$9EC3X5IBHLwq2RehHNvWc0
interface Ethernet0
ip address 210.93.105.1 255.255.255.0
no ip mroute-cache
no ip route-cache
interface Serial0
no ip address
no ip mroute-cache
no ip route-cache
shutdown
interface Serial1
ip address 204.204.7.2 255.255.255.0
no ip mroute-cache
no ip route-cache
router rip
network 204.204.7.0
network 210.93.105.0
ip host LAB-A 102.5.5.1 205.7.5.1 201.100.11.1
ip host LAB-B 201.100.11.2 219.17.100.1 199.6.13.1
ip host LAB-C 199.6.13.2 223.8.151.1 204.204.7.1
ip host LAB-D 204.204.7.2 210.93.105.1
ip host LAB-E 210.93.105.2
no ip classless
line con 0
password cisco
login
line aux 0
line vty 0 4
```



```
password cisco
login
```

Router: LAB-E

```
LAB-E#show run

Building configuration...
Current configuration:
version 11.1
service udp-small-servers
service tcp-small-servers
hostname LAB-E
enable secret 5 $1$q/QJ$EA8tfOg1/Rxn/28FSrLgJ/
interface Ethernet0
ip address 210.93.105.2 255.255.255.0
interface Serial0
no ip address
shutdown
interface Serial1
no ip address
shutdown
router rip
network 210.93.105.0
ip host LAB-A 192.5.5.1 205.7.5.1 201.100.11.1
ip host LAB-B 201.100.11.2 219.17.100.1 199.6.13.1
ip host LAB-C 199.6.13.2 223.8.151.1 204.204.7.1
ip host LAB-D 204.204.7.2 210.93.105.1
ip host LAB-E 210.93.105.2
no ip classless
line con 0
password cisco
login
line aux 0
line vty 0 4
password cisco
login
!
```


Lab 9.2.4.1 Show ARP & clear ARP

Estimated time: 30 min.

Objectives:

- Become familiar with the router **`show arp`** command
- Become familiar with the router **`clear arp`** command

Background:

In this lab you will view the ARP table stored in the router and clear the router's ARP table. These two commands are very important in troubleshooting a network problem. The router keeps very detailed information about MAC address and associated IP addresses. From time to time this information can become corrupt and will cause packet delivery problems. When this happens the router ARP table must be cleared and rebuilt.

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal program that is configured to connect to the router. You should review Semester 2 online curriculum Chapter 9 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`Enable`**
- **`Show arp`**
- **`Clear arp`**
- **`Ping`**

Resources Required:

- PC with monitor, keyboard, mouse, power cords, and so on
- Windows operating system (Win 95, 98, NT, or 2000) installed on PC
- HyperTerminal program configured for router console access

Websites Sites Resources:

- Routing basics
- General information on routers
- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary
- Beginning IP for new users

Notes:

Step 1 - Login to the router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Show the router's ARP table.

Task: Enter **show arp** at the router prompt.
Explanation: The router will respond with the ARP table that shows IP address to MAC address to interface number.

1. What three (3) important pieces of information are displayed?

Step 3 - Enter privileged mode.

Task:

a. Enter **enable** at the command prompt.
b. Enter the password of **class**.

Explanation: You use the **enable** command to enter privileged EXEC mode.

Step 4 - Enter the help command.

Task: Enter the help command by typing ? at the router prompt.
Explanation: The router responds with all commands available in Privileged-Mode.

2a. What is the significance of entering ? at the router prompt?

2b. Does the clear command appear as an option?

Step 5 - Clear the ARP table.

Task: Enter **`clear arp`** command at the router prompt.
Explanation: The router will clear the arp table.

Step 6 - Show the ARP table.

Task: Enter **`show arp`** command at the router prompt.
Explanation: The router will respond with the ARP table.

3. Are there any entries in the ARP table?

---

4. Looking at the IP address of the ARP entries what are the entries for?

Step 7 - Generate network traffic.

Task: Ping all interfaces on the network.
Explanation: This will generate network traffic between routers.

Step 8 - Show the ARP table.

Task: Enter **`show arp`** command at the router prompt.
Explanation: The router will respond with the ARP table.

5. Are there any new entries in the ARP table?

Step 9 - Generate network traffic.

Task: Open an MS-DOS command prompt (Start/Programs/MS DOS Command Prompt). **Ping** all the workstations on the lab network. Note: You will have to make sure that all workstations have proper IP addressing for the network they are connected to and a default gateway.
Explanation: This will generate network traffic from workstation to workstation.

Step 10 - Show the ARP table.

Task: Enter **`show arp`** command at the router prompt.
Explanation: The router will respond with the ARP table.

6. Are there any new entries in the ARP table?

---

7. Explain why there were no new entries in step 8 and there are in step 10.

Step 11 - Exit the router.

Lab 9.2.4.2 ARP challenge

Estimated time: 30 min.

Objectives:

- Practice working with ARP tables

Background:

You and your group have been assigned to help a system administrator of a network for XYZ company. The system administrator of this network would like to know the MAC addresses of each of the Ethernet interfaces on the routers.

Tools / Preparation:

Prior to starting this lab you will need to have the equipment for the standard five-router lab available (routers, hubs, switches, cables, and so on). The routers should be pre-configured by the instructor or lab assistant with the correct IP interface settings, and so on. The workstations should also be pre-configured to have the correct IP address settings prior to starting the lab. The routers, hubs, and workstations should be labeled.

Work in teams of three or more. Before beginning this lab you should review Semester 2 On-line Chapter 9.

The following resources will be required:

1. 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
2. 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
3. 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
4. One Ethernet switch (Cisco Catalyst 1900 or comparable).
5. 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
6. 3 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
7. CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
8. AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Web Site Resources:

- Routing basics
- General information on routers
- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

Step 1 - Find MAC address for all Ethernet interfaces.

Verify that the routers and workstations are setup according to the standard five-router lab diagram. When you are done with this, view the ARP tables and find out the MAC address of all surrounding routers. Be sure to record the ARP tables of the other group's routers. This will allow you to construct a diagram of all the routers with their IP and MAC addresses. You might want to write down a quick step by step example of how you found the MAC address to one of the routers.

1. List the following MAC address for the routers:

LAB-A E0

LAB-A E1

LAB-B E0

LAB-C E0

LAB-D E0

LAB-E E0

Step 2 - Generate network traffic.

From the workstations ping another workstation on a different router. Then from the router issue the **show arp** command from a privileged prompt.

2. List the MAC address for the workstations that are connected to the router.

Lab 10.1.4 IP addressing & subnets

Estimated time: 30 min.

Objectives:

This Lab will focus on your ability to accomplish the following tasks:

- Design and implement a 5-router network topology
- Develop an IP addressing scheme based on the topology
- Use a single Class C network address with subnets for LANs and WANs
- Assign IP addresses to router interfaces and hosts
- Diagram the network using ConfigMaker

Background:

In this lab you will work with other group members to design a 5-router network topology and an IP addressing scheme. You must come up with a proper IP addressing scheme using a single Class C network address (204.204.7.0) and multiple subnets. You will then use ConfigMaker to make a diagram of the network you have designed. You have creative freedom in designing your network.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard five-router lab available (routers, hubs, switches, cables, and so on). Since this is a challenge lab, the routers may or may not be pre-configured with the correct IP interface settings, and so on. If they are, you will need to change the IP addresses to be different form those of the standard lab setup. The workstations may also be pre-configured to have the correct IP address settings prior to starting the lab. The IP addressing configuration of the workstations will also need to be changed. If the actual lab equipment is not available to configure, design the network using the worksheets provided in this lab. Work in teams of five or more.

The following resources will be required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 4 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary

Notes:

Step 1 - Design the physical topology of the network.

You should have at least five routers in different geographical locations. You should have at least one Ethernet LAN off of each router. Sketch out the topology as you go. Answer the following questions to assist in planning:

1. How many routers will you have?

2. Where will the routers be located?

3. How many switches will you have?

Step 2 - Develop an IP addressing scheme.

Review your topology sketch from step one. Using a single Class C address of 204.204.7.0, create a subnetwork design for your topology. Document your scheme by indicating where you will put each of the subnets. Answer the following questions to assist in planning.

4. How many LANs are there?

5. How many WANs are there?

6. How many unique subnets will you need?

_____

7. How many hosts per subnet (LAN and WAN) will you have?

_____

8. How many IP addresses (hosts + router interfaces) will be required?

_____

9. What is your Class C network address?

_____

10. How many bits will you borrow from the host portion of the network address?

_____

11. What will your subnet mask be?

_____

12. How many total useable subnets will this allow for?

_____

13. How many hosts per subnet will this allow for?

_____

Step 3 - Assign IP addresses to each device interface.

Using the table assign an IP address to each device interface or range of devices (hosts) that will require an IP address. Switches do not require an IP address but you may assign one if you want to. Hubs will not have an IP address. (answers will vary)

Device name / model	Interface	IP address	Subnet mask	Default gateway

14. Which interfaces will require clock rate to be set?

_____

Step 4 - Diagram the network using ConfigMaker.

Use Cisco ConfigMaker to create a network diagram and add all configuration information such as IP addresses and subnet masks. ConfigMaker will allow you to enter all interface IP addresses and help you create a finished diagram. You should be familiar with ConfigMaker if you have completed lab 6.5.2.2. Use the web site listed in the overview section to download ConfigMaker if you do not have it.

Reflection:

_____

_____

_____

_____

_____

Lab 10.4.1 Topology challenge lab

Estimated time: 30 min.

Objectives:

- Design an IP addressing scheme based on a given network topology
- Use multiple Class C network addresses for LANs and WANs
- Assign IP addresses to router interfaces
- Diagram the network using ConfigMaker

Background:

You and your group members have just received your Cisco certification. Your first job is to work with other group members in designing a topology and IP addressing scheme. It will be a five-router topology similar to the standard five-router lab diagram as shown, but with a few changes. Refer to the modified five-router lab diagram shown in the worksheet. You must come up with a proper IP addressing scheme using multiple Class C addresses which are different from those of the standard lab setup. You will then use ConfigMaker to do your own diagram of the network. You may do this lab using the worksheets or work with the actual lab equipment if it is available.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard five-router lab available (routers, hubs, switches, cables, and so on.). Since this is a challenge lab, the routers may or may not be configured with IP interface settings, and so on. If they are, you will need to change the IP addresses to be different from those of the standard lab setup. The IP address configuration of the workstations will also need to be changed. If the actual lab equipment is not available to configure, design the network using the worksheets provided in this lab. Work in teams of five or more.

The following resources will be required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 4 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.
- Cisco ConfigMaker software version 2.3 or later (See below for web site).

Websites Sites Required:

Routing basics
General information on routers
2500 series routers
1600 series routers
Terms and acronyms
IP routing protocol IOS command summary

Notes:

Step 1 - Review the physical connections on the standard lab setup.

Review the standard semester 2 lab diagram in the overview section of this lab and check all physical devices, cables and connections if the physical lab setup is available.

Step 2 - Develop an IP addressing scheme.

With the standard five-router lab configuration shown in the overview section, there are eight (8) networks. Five (5) of these are Ethernet Local Area Networks (LANs) and three (3) of them are serial Wide Area Networks (WANs). Review the modified setup of the lab diagrammed below. Using multiple Class C addresses similar to the existing standard lab, select addresses and document the IP addressing scheme by indicating where you will put each of the Class C addresses. Answer the following questions to assist your team in planning the network IP address scheme.

1. How many LANs are there?

2. How many WANs are there?

3. How many unique Class C network addresses will you need?

4. How many devices are there?

5. How many device interfaces will require IP addresses?

Step 3 - Assign IP addresses to each device interface.

Use the table below to identify each router interface that will require an IP address. Switches do not require an IP address but you may assign one if you want to. Hubs will not have an IP address.

Device name / model	Interface	IP Address	Subnet mask	Default gateway

6. Which interfaces will require clock rate to be set?

Step 4 - Diagram the network using ConfigMaker.

Use Cisco ConfigMaker to recreate the network diagram in the worksheet and add all configuration information such as IP addresses and subnet masks. ConfigMaker will allow you to enter all interface IP addresses and help you create a finished diagram. Choose your own device names. You should be familiar with ConfigMaker if you have completed lab 6.5.2.2.

Reflection:

What did you learn from designing a topology with such a large group of people?

In what router mode did you spend most of your time?

Could you have done it any other way? If so how?

When doing this lab, how could a TFTP server have been useful?

Lab 12.1.5 Static Routes

Estimated time: 30 min.

Objectives:

- Configure a static route between direct neighboring routers using the ip route command.
- Copy the running configuration to startup configuration.

Background:

In this lab you will configure a static route between neighboring routers. Static routes are routes that cause packets moving between a source and a destination to take a specified path. They are typically defined manually by a network administrator. Routing updates are not sent on a link if it is only defined by a static route, thereby conserving bandwidth. Another application for a static route is security since dynamic routing tends to reveal everything known about a network. Static routes are sometimes used for remote sites and for testing of a particular link or series of routers in your internetwork.

Tools / Preparation:

Prior to starting this lab you will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal program that is configured to connect to the router. You may want to review Chapter 18 in the Cisco Networking Academy First-Year Companion Guide and review semester 2 online curriculum Chapter 12 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`Enable`**
- **`Show arp`**
- **`Show startup-config`**
- **`Configure terminal`**
- **`IP route`**
- **`Show running-config`**
- **`copy`**
- **`Ping`**

Resources Required:

- PC with monitor, keyboard, mouse, power cords, and so on
- Windows operating system (Win 95, 98, NT, or 2000) installed on PC
- HyperTerminal program configured for router console connection
- PC connected to the router console port with a roll-over cable

Websites Required:

- Routing basics
- General information on routers

- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

Step 1 - Login to router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Test layer 3 (network) connectivity.

Task: Enter **`ping`** xxx.xxx.xxx.xxx
Explanation: xxx.xxx.xxx.xxx is an IP address of one of your neighboring routers.

1. Did the router's interface respond with a successful ping?

Step 3 - Enter privileged mode.

Task:
a. Enter **`enable`** at the command prompt.
b. Enter the password of **class**.
Explanation: Use the **`enable`** command to enter privileged EXEC mode.

Step 4 - Show the backup configuration file.

Task: Enter **`show startup-config`** (abbrev. **`show start`**) at the router prompt.
Explanation: The router will display information on the backup configuration file stored in NVRAM.

2. What routing protocols or static routes are defined, if any?

Step 5 - Enter global configuration mode.

Task: Enter **`configure terminal`** (abbrev. **`config t`**) at the router prompt.
Explanation: To configure the router you must enter the global configuration mode. Notice how the router has changed after this command.

3. What does the router prompt look like?

Step 6 - Enter help facility.

Task: Enter **`IP route ?`** command at the router prompt.
Explanation: The router will respond with the description available for IP route.

4. What was the router's response?

Step 7 - Enter the help facility.

Task: Enter **`ip route xxx.xxx.xxx.xxx ?`** at the router prompt.
Explanation: xxx.xxx.xxx.xxx is the network address for which you want a static route.

5. What was the router's response?

Step 8 - Enter the help facility.

Task: Enter **`ip route`** xxx.xxx.xxx.xxx yyy.yyy.yyy.yyy at the router prompt.
Explanation: xxx.xxx.xxx.xxx is the network address of the destination network and yyy.yyy.yyy.yyy is the subnet mask of the destination network.

6. What was the router's response?

Step 9 - Enter a static route.

Task: Enter **`ip route xxx.xxx.xxx.xxx yyy.yyy.yyy.yyy zzz.zzz.zzz.zzz`** at the router prompt.
Explanation: xxx.xxx.xxx.xxx is the network address of the destination network and yyy.yyy.yyy.yyy is the subnet mask of the destination network. zzz.zzz.zzz.zzz is the IP address of the direct neighbor interface.

Step 10 - Exit the router global configuration mode.

Task: Enter **`exit`** at the router prompt.
Explanation: The router will exit the global configuration mode.

7. What does the router prompt look like?

Step 11 - Show the running configuration.

Task: Enter **`show running-config`** at the router prompt.
Explanation: The router will show the active configuration file.

8. Was there an IP route with the static route you configured in the active configuration file?

Step 12 - Copy the active configuration to the backup configuration.

Task: Enter **`copy running-config startup-config`** at the router prompt.
Explanation: This command will place a backup copy of running-config into NVRAM.

Step 13 - Test the static route with the `ping` command.

Task: Enter **`ping xxx.xxx.xxx.xxx`** at the router prompt.
Explanation: xxx.xxx.xxx.xxx is the neighboring router to which you setup a static route.

9. Was the neighboring router interface reachable?

Step 14 - Exit the router.

Lab 12.3.5 RIP Routing

Estimated time: 45 min.

Objectives:

- Configure RIP as your Routing Protocol

Background:

In this lab you will configure RIP as the routing protocol. RIP is a distance-vector routing protocol. Hop count is used as the metric for path selection and has a maximum allowable hop count of 15. RIP broadcasts routing updates consisting of its routing table to its neighbors every 30 seconds by default. RIP is a standard protocol which is appropriate for relatively small homogeneous networks.

Tools / Preparation:

Prior to starting the lab the teacher will have to login to each router and delete all router RIP and static route entries from all of the routers. You will need to connect a PC workstation (with the HyperTerminal program loaded) to a router using the router's console interface with a roll-over (console) cable. All lab work is done through the HyperTerminal program that is configured to connect to the router. You may want to review Chapter 18 in the Cisco Networking Academy First-Year Companion Guide and review Semester 1 on-line chapter 12 prior to starting this lab. Work individually or in teams. Be familiar with the following commands:

- **`Enable`**
- **`Show IP route`**
- **`Show startup-config`**
- **`Configure terminal`**
- **`Network`**
- **`Show running-config`**
- **`Copy`**
- **`Show IP protocols`**
- **`Router RIP`**

Resources Required:

- PC with monitor, keyboard, mouse, power cords, and so on
- Windows operating system (Win 95, 98, NT, or 2000) installed on PC
- HyperTerminal program configured for router console connection
- PC connected to the router console port with a roll-over cable

Websites Sites Required:

- Routing basics
- General information on routers
- 2500 series routers
- 1600 series routers

- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

Step 1 - Login to the router.

Explanation: Connect to the router and login. Enter the password **cisco** if prompted.

Step 2 - Test layer 3 connectivity.

Task: Enter **`ping xxx.xxx.xxx.xxx`**
Explanation: Ping all interfaces on your router and direct neighboring routers.

1. Did all interfaces respond with a successful ping?

Step 3 - View the routing table.

Task: Enter **`show IP route`** at the router prompt.
Explanation: The router will respond with its routing table.

2. Is there any routing protocol defined?

Step 4 - Enter privileged mode.

Task:
a. Enter **`enable`** at the command prompt.
b. Enter the password of **`class`**
Explanation: You use the **`enable`** command to enter privileged EXEC mode.

Step 5 - Show information about the active configuration file.

Task: Enter **`show running-config`** at the router prompt.
Explanation: The router will display information on the active configuration file.

3. Are there any static routes defined?

Step 6 - Enter global configuration mode.

Task: Enter **`configure terminal`** at the router prompt.
Explanation: To configure the router you must enter the global configuration mode. Notice how the router prompt has changed after this command.

4. What does the router prompt look like?

Step 7 - Enable RIP as your routing protocol.

Task: Enter **`router RIP`** command at the router prompt.
Explanation: This will enable RIP on the router.

5. What changed in the router prompt?

Step 8 - Enable RIP routing on a particular IP network.

Task: Enter **`network xxx.xxx.xxx.xxx`** at the router prompt.
Explanation: xxx.xxx.xxx.xxx is the network address on which you want to enable RIP on.

Step 9 - Enable RIP routing on a particular IP network.

Task: Repeat step eight for all the networks directly connected to the router.

Step 10 - Exit router configuration mode.

Task: Enter **`exit`** at the router prompt.
Explanation: The router will exit out of router configuration mode and you will be in global configuration mode.

Step 11 - Exit the router global configuration mode.

Task: Enter **`exit`** at the router prompt.
Explanation: The router will exit the global configuration mode.

Step 12 - Show the running configuration.

Task: Enter **`show running-config`** at the router prompt.
Explanation: The router will show the active configuration file.

6. Is the router RIP protocol turned on and advertising the networks you defined?

Step 13 - Copy the active configuration to the backup configuration.

Task: Enter **`copy running-config startup-config`** at the router prompt.
Explanation: This command will permanently write the configuration change to memory.

7. What does this command do?

Step 14 - View the IP protocols.

Task: Enter **`show IP protocols`** at the router prompt.
Explanation: The router will display values about routing timers and network information associated with the entire router.

8. When is the next update due?

Step 15 - View the routing table.

Task: Enter **`show IP route`** at the router prompt.
Explanation: The router will display its routing table.

9. How many routes were discovered by RIP?

Step 16 - Display the status and global parameters.

Task: Enter **`show IP interface`** at the router prompt.
Explanation: The router displays the status and global parameters associated with an interface.

10. What information did you receive from this command?

Step 17 - Display RIP routing updates as they are sent and received.

Task: Enter debug **`IP RIP`** at the command prompt.
Explanation: This command allows you to display RIP routing updates as they are sent and received.

11. What important information did you receive from this command?

Step 18 - Turn off debug for RIP.

Task: Enter **`no debug IP RIP`** at the router prompt.
Explanation: This command will turn off the debugging for RIP.

Step 19 - Exit the router.

Lab 12.5.1 RIP Convergence Challenge

Estimated time: 60 min.

Objectives:

- Gain experience and knowledge of routing protocols
- Work with and compare static routes and dynamic routes
- Understand the process of convergence

Background:

As a system administrator, there will be times when configuring static routes can be very useful. Static routes are useful for stub networks because there is only one way to get to that network. Security is another reason to use static routes. If you have a network or networks that you do not want the rest of the network to be able to "see" you would not want RIP or other routing protocols sending periodic updates to other routers. With simple networks (few routers) it is sometimes more efficient to use static routes since it conserves bandwidth on WAN links. In this lab you will use static routes for troubleshooting purposes and to see their relationship to dynamic routes and routing protocols.

Tools / Preparation:

Prior to starting this lab you will need to have the equipment for the standard five-router lab available (routers, hubs, switches, cables, and so on). The routers should be pre-configured by the instructor or lab assistant with the correct IP interface settings, and so on. RIP should be enabled on all routers. The workstations should also be pre-configured to have the correct IP address settings prior to starting the lab. The routers, hubs, and workstations should be labeled.

Work in teams of three or more. Before beginning this lab you may want to review Chapter 18 in the Cisco Networking Academy First-Year Companion Guide and Semester 2 On-line Chapter 12.

Resources Required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 3 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Websites Sites Required:

- Routing basics
- General information on routers
- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

_____

_____

_____

_____

Step 1 - Show ip route.

Verify that RIP is enabled and there are no static routes on any of the routers. If there are static routes then remove them with the **`no IP route xxx.xxx.xxx.xxx`** command in global config mode.

Step 2 - Enable debugging on Lab-D.

When you use the command **`debug ip rip`** you will be able to see all routing updates the router is receiving and sending. Turn on debugging on Lab-D.

Step 3 - Shut down the serial 1 interface on Lab-B.

Shutdown the serial 1 interface on Lab-B with the shutdown command. Watch the debugging information on Lab-D and issue the **`show ip route`** command there.

1. Has the output from the command **`show ip route`** changed from when you issued the command in step one?

_____

2. Which networks are inaccessible?

_____

Step 4 - Converged network.

After about five minutes issue the **`show ip route`** command on Lab-D.

3. Are the networks that were inaccessible in question two listed in the output from the **`show ip route`** command?

Step 5 - Enter static routes.

Bring Lab-B's serial 1 interface back up. Then enter static routes for all five routers leaving RIP enabled. Issue the **`show ip route`** command. Your output from the **`show ip route`** command should look like this:

```
Lab-D#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP D - EIGRP, EX
- EIGRP external, O - OSPF, IA - OSPF inter area N1 - OSPF NSSA external type 1,
N2 - OSPF NSSA external type 2 E1 - OSPF external type 1, E2 - OSPF external type 2,
E - EGP i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default U - per-user
static route, o - ODR

Gateway of last resort is not set
C 204.204.7.0/24 is directly connected, Serial1
S 223.8.151.0/24 [1/0] via 204.204.7.1
S 201.100.11.0/24 [1/0] via 204.204.7.1
S 219.17.100.0/24 [1/0] via 204.204.7.1
S 192.5.5.0/24 [1/0] via 204.204.7.1
S 199.6.13.0/24 [1/0] via 204.204.7.1
S 205.7.5.0/24 [1/0] via 204.204.7.1
C 210.93.105.0/24 is directly connected, Ethernet0
```

Note that there are no R-RIP entries in the routing table.

Step 6 - Shut down the serial 1 interface on Lab-B.

After you shutdown the serial 1 interface on Lab-B watch the debugging information on Lab-D.

4. Do you see any information that would let you know that Lab-B's serial 1 interface is down?

_____

5. Why or why not?

_____

Step 7 - Turn off debugging on Lab-D.

Turn off debugging on Lab-D using the **`undebug all`** command.

6. Now that you have a good understanding of static routes, what are the benefits of dynamic routes?

_____

_____

Lab 12.5.2 Routing Loops Setup Challenge

Estimated time: 30 min.

Objectives:

- Configure a WAN connection between Lab-A and Lab-E.
- Demonstrate your ability to configure Serial interfaces.

Background

In this lab you will setup a WAN connection between Lab-A and Lab-E to create alternate paths in the standard router lab setup. Using a set of WAN serial cables, connect Lab-A Serial 1 to Lab-E Serial 0. Remember to set the clock rate on the DCE side of the cable (Lab-E's Serial 0 interface).

Tools / Preparation:

Prior to starting this lab you will need to have the equipment for the standard five-router lab available including routers, hubs, switches, and cables. All routers should be pre-configured by the instructor or lab assistant using the configuration imformation for the standard five-router lab topology. The workstations should also be pre-configured to have the correct IP address settings prior to starting the lab. The routers, hubs and workstations should be labeled.

This lab assumes that the equipment is assembled and connected in the standard lab topology. Work in teams of three or more. You may want to review Chapter 11 in the Cisco Networking Academy First-Year Companion Guide and review Semester 2 On-line Chapter 12.

Resources Required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 4 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Websites Sites Required:

- Routing basics
- General information on routers

- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

Step 1 - Verify that all physical connections are correct.

Review the standard Semester Two Lab diagram in the overview section of this lab. You will add a fourth set of V.35 WAN serial cables (DTE male/ DCE female) to connect from router Lab-A interface S1 to router Lab-E interface S0.

Step 2 - Configure Lab-A serial 1 interface.

Login to the router and enter the interface configuration mode. Configure interface serial 1 with the following information (this is a new class C IP address):
IP address 220.68.33.2
Subnet Mask 255.255.255.0
Bandwidth of 56

Step 3 - Configure IP host and RIP networks.

After you have finished the configuration for the interface, add the 220.68.33.0 network to the RIP routing process on LAB-A. To do this use the **`router rip`** command to enter routing configuration mode, then use the **`network`** command to add the 220.68.33.0 network to RIP. Also, add the new IP address to the host table entry for routers Lab-A and Lab-E for name resolution to all routers.

Step 4 - Configure Lab-E serial 0 interface.

Repeat steps 2 and 3 for Lab-E interface serial 0 with the following information:
IP address 220.68.33.1
Subnet Mask 255.255.255.0
Clock rate 56000
Bandwidth of 56

Step 5 - Test your setup.

When you have configured Lab-A's and Lab-E's interfaces, check off the items in the list:

- Ping from all routers to 220.68.33.1
- Ping from all routers to 220.68.2 2.2

- Ping from all Workstations to 220.68.33.1
- Ping from all Workstations to 220.68.33.2
- Telnet from Lab-C to 220.68.33.1
- Telnet from Lab-C to 220.68.33.2
- Telnet from Workstation to 220.68.33.1
- Telnet from Workstation to 220.68.33.2

Step 6 - Troubleshooting.

If you were not able to finish step 5 then use your troubleshooting skills learned in previous labs to correct the problem. After you have successfully finished step 5 save the running configuration to the startup configuration for all routers.

Lab 12.5.3 Preventing Routing Loops

Estimated time: 45 min.

Objectives:

- Understand methods of controlling routing loops including hold-down timers, defining a maximum hop count, counting to infinity, poison reverse and split-horizon.
- Adjust the RIP maximum hop count to control routing loops.

Background:

In the previous challenge lab, you saw how long it took to converge when a link went down. In this lab, your task is to find out how to prevent and control routing loops. The use of hold-down timers, defining a maximum hop count, counting to infinity, poison reverse and split-horizon are all methods of controlling routing loops. You will use the RIP hop count metric to control routing loops in this lab. You should have finished Lab 12.5.2 and have the fourth set of WAN cables connected from Lab-A Serial 1 to Lab-E Serial 0. To learn more about timers look at the worksheet answers "Understanding Timers".

Tools / Preparation:

Prior to starting this lab you will need to have the equipment for the standard five-router lab available. The routers and workstations should be pre-configured by the instructor or lab assistant with the correct IP settings prior to starting the lab. Before beginning this lab you may want to review Chapters 11 in the Cisco Networking Academy First-Year Companion Guide and Semester 2 On-line Chapter 12.

Resources Required:

- 5 PC workstations (min.) with Windows operating system and HyperTerminal installed.
- 5 Cisco Routers (model 1600 series or 2500 series with IOS 11.2 or later).
- 4 Ethernet hubs (10BASE-T with 4 to 8 ports).
- One Ethernet switch (Cisco Catalyst 1900 or comparable).
- 5 serial console cables to connect workstation to router console port (with RJ-45 to DB9 converters).
- 4 Sets of V.35 WAN serial cables (DTE male/ DCE female) to connect from router to router.
- CAT5 Ethernet Cables wired straight through to connect routers and workstations to hubs and switches.
- AUI (DB15) to RJ-45 Ethernet transceivers (Quantity depends on the number of routers with AUI ports) to convert router AUI interfaces to 10BASE-T RJ-45.

Websites Sites Required:

- Routing basics
- General information on routers

- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary

Notes:

Step 1 - Turn on debugging.

Working with router Lab-C, turn on debugging with the **`debug ip rip`** command.

Step 2 - Shutdown Lab-A's Ethernet 0 interface.

Shutdown Lab-A's Ethernet 0 interface. From Lab-C, watch the routing information and use the **`show ip route`** command to see how many routing updates it takes to flush out Lab-A's Ethernet 0 network.

1. How many updates did it take to converge?

Step 3 - Enable Lab-A's Ethernet 0 interface.

On Lab-A bring Ethernet 0 back up and allow enough time for the network to converge.

Step 4 - Configure default metric, timers basic and split-horizon on Lab-C.

There are other timers that can be modified to help avoid routing loops. This lab focuses on hop count. Change the RIP maximum hop count on router Lab-C to 10 (the default is 16), adjust the routing timers and split horizon using the following commands:

```
Lab-C#conf t
Lab-C(config)#router rip
Lab-C(config-router)#default-metric 10
Lab-C(config-router)#timers basic 30 60 150 30
Lab-C(config-router)#exit
Lab-C(config)#int s0
Lab-C(config-if)#ip split-horizon
Lab-C(config-if)#int s1
Lab-C(config-if)#ip split-horizon
```



```
Lab-C(config-if)#^Z
Lab-C#
```

Step 5 - Shutdown Lab-A's Ethernet 0 interface.

Shutdown Lab-A's Ethernet 0 interface. From Lab-C, watch the routing information and use the **`show ip route`** command to see how many routing updates it takes to flush out Lab-A's Ethernet 0 network.

2. How many updates did it take to converge?

_____

3. Compare question 1 and 2 and explain why the network converged faster after changing the default metric, timers, and split horizon.

_____

Lab 13.1.6 Troubleshooting 5-router network - Overview

Estimated time: 30 min.

Objectives:

- Troubleshoot problems in the five-router lab network
- Document the problems found and corrective action taken
- Prepare for Part B of the Final Exam (Router Lab Troubleshooting)

Background:

For this lab, your instructor has created/introduced multiple problems in the network. You have a limited amount of time in which to find and solve the problems so that you can get the entire network up and running.

The tools that you may use for the hardware are in your tool kit. The tools that you may use for the software (IOS) include **`ping`**, **`trace ip route`**, **`telnet`**, and **`show arp`**. You may use your Engineering Journal and any Web-based resources (including the curriculum) that are available. As you discover the problems you will document them along with what you did to correct them.

Tools / Preparation:

Prior to starting this lab you should have the equipment for the standard five-router lab available. All routers and workstations should be properly configured. You will be asked to leave the room and your instructor or lab assistant will introduce three to five problems into the lab setup.

Step 1 - Review the physical connections on the standard lab setup.

Review the standard semester 2 lab diagram in the overview section of this lab and check all physical devices, cables and connections.

Step 2 - Troubleshooting induced network problems.

Basic Problem descriptions:

a) We cannot ping a host on LAB-E's network from a host on LAB-A's network.
b) We cannot telnet from one router to another router's host name.

The instructor will introduce three to five problems into the network that can cause these high level symptoms. Your team will have a fixed time period (20 to 30 minutes) to correct the problems. You may use your journals and toolkits to troubleshoot the problems.

Step 3 - Document the problems discovered.

Write down the problems as you encounter them and then indicate what you did to correct them. When you are able to ping from a Lab-A workstation to a Lab-E

workstation and telnet from one router to another router's host name, have the instructor verify that you have corrected all problems.

Prob. #	Problem discovered	Solution	Instructor verification
1			
2			
3			
4			
5			

